The Engineer

LONDON, FRIDAY, MARCH 14, 1941.

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1940 No. 877
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The Engineer

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IMPORTANT NOTICE

All correspondence dealing with Editorial, Advertising and Subscription Matters should be addressed to: 28, ESSEX STREET, STRAND, LONDON, W.C. 2

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"THE METALLURGIST"

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next due, April 25th.

ADVERTISEMENTS

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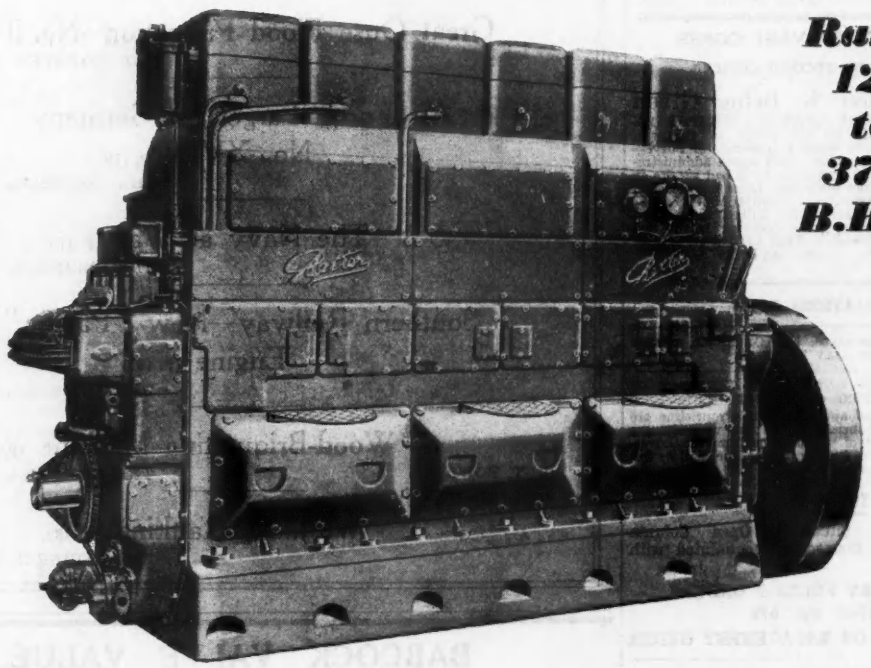

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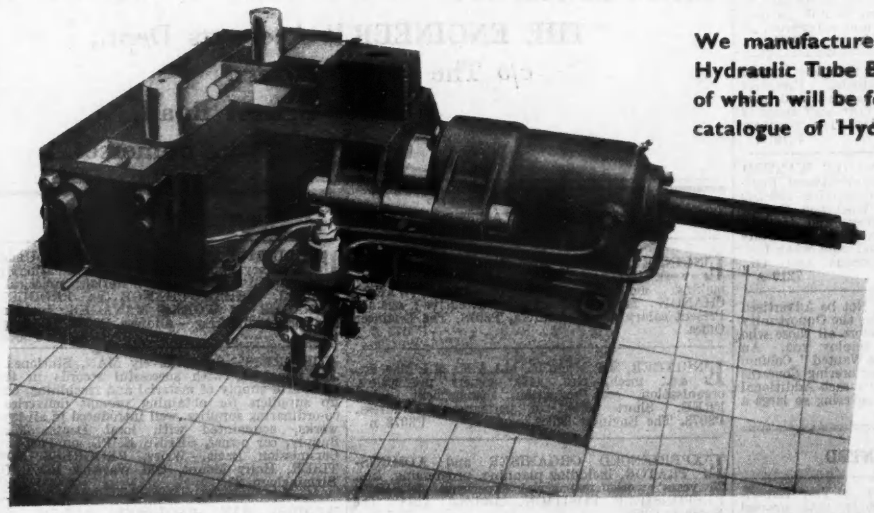

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Record Naval Construction

IN a speech made at Grantham on Saturday, March 8th, when opening Grantham's War Weapons Week, Sir Victor Warrender, the Financial Secretary to the Admiralty, said that by the end of March Great Britain would have completed 480 warships, large and small, in a year. That figure, he said, was more than five times as many as the ships built in any year since the naval programme began. Sir Victor added that such vigorous activity must be perpetually nourished by money and still more money. Speaking of our naval men, he said that they were getting the utmost out of every ton of new construction, and were at the same time tending old vessels with such skill and care that they were performing feats of endurance never expected of them by their designers. As an instance, one of our destroyers spent at sea 274 days of the first year of the war and steamed over 62,000 miles. That, he contended, was a feat which was not to be underestimated, considering the complicated and delicate mechanism which was crowded into a modern vessel of war. If those on active service, the users of the weapons, could show such care, then we at home in the arsenal of war should not be behindhand. Concluding his speech, Sir Victor recalled that it was said of the Commander-in-Chief of the Grand Fleet in the last war that he could lose the war in a day. If we failed to use every exertion to save money and shipping space, we would not merely jeopardise our first line of defence, but would lose the war for our country as surely as would a rash or incompetent admiral.

Criticism of the Railways

IN his chairman's speech at the eighteenth annual meeting of the London Midland and Scottish Railway Company, which took place in London on Friday, March 7th, Lord Stamp referred to operating difficulties and uninformed criticism of the railways. The snowstorms and blizzards with fog of January last, particularly at the end of the month, were, he said, the worst in living memory. In three days lines were blocked in 313 places, in the aggregate for 48,000 hours, considerably upsetting industry and the transport of coal. Speaking of the work of the staff and their efforts to overcome every obstacle, Lord Stamp went on to say the officials might easily have given in and put up a notice, "No through travel to London to-day." Instead, they rearranged, improvised, felt their way from control to control with communication often interrupted and merely local, and they overcame every obstacle. Their only reward was circumstantial accounts by certain know-all passengers of inefficiency, readily accepted as good copy by some papers. Such comments had a cruel effect upon the *morale* of the workers, and were against the public interest, and it would be better not to put those statements into print until it had been ascertained in confidence from the authorities whether there were substantial reasons that could not be published, why the accounts so given were not an adequate presentation of the facts. The railways had no wish to escape proper criticism, but under the veil of secrecy they could not answer back and defend the staff. He had seen the serious effects of that upon them, and could affirm that the haste to kick the men round was not calculated to maintain our war effort and the *morale* of the staff. In most countries of the world railways seemed to be fair, or rather unfair, game for anyone. People who would be decently careful not to make disparaging statements, without weighing their words, concerning any person or other institution, did not hesitate to declare roundly that their trouble was "due to the railways," and, like Pilate, they did not wait for an answer—indeed, they usually assumed there was no answer. Railways and their men were certainly not perfect and even if they were they would not please everyone. But his (Lord Stamp's) examination of the comments and complaints showed that there was a complete and very creditable answer to nine-tenths of them if it could be given. He had, concluded Lord Stamp, such an admiration for the work the men had done under discouraging conditions that he felt bound to make this plea for fairer comment under present conditions if they were to continue to give service of that quality.

Government Control of the Railways

THE same complaint of unjustifiable criticism was made by Sir Ronald Matthews, at the eighteenth annual meeting of the London and North-Eastern Railway Company, which took place in London on Friday, March 7th. In his speech Sir Ronald said that while it was not permissible to lift more than the smallest corner of the veil which must perforce shroud the operations of the undertaking during the whole of last year, that was the more regrettable because, both in Parliament and in certain organs of the Press, statements had been made which might lead the uninformed public to believe that the whole of the country's war effort was being held up owing to the chaotic conditions prevailing on the railways. Nothing, of course, could be further from the truth, but in times when the company's servants, from the highest to the lowest, were doing everything in their power to maintain, often at great personal risk, the flow of traffic, one did resent most deeply the so-called "amazing disclosures" which on examination proved to be nothing more than trivial complaints that passenger trains were running less punctually than before the war. Every effort was being made to meet the convenience of the travelling public, but it should be obvious that in time of war the ordinary passenger could not expect the high standards of peacetime travel and that precedence must be given to the movement of troops and supplies, while due allowance must be made for delays inseparable from air-raid warnings and black-out conditions. It was not difficult to fathom the motives of those who were attempting to saddle the boards with responsibility for all the troubles they alleged to exist, ignoring the fact that railway policy from the outbreak of war had been settled by the Government, and that, in their eagerness to make a case for nationalisation they were, in fact, condemning the system they were out to praise. When the veil could be lifted it would be seen that the great railway undertakings, both as regards personnel and equipment, had stood up successfully to the testing conditions of wartime operation.

Employment Returns

IT was officially announced by the Ministry of Labour and National Service on Friday, March 7th, that the number of men and boys registered at Employment Exchanges in Great Britain as wholly unemployed at February 10th was 217,546, a decrease of 41,416 as compared with January 13th. The number included, who had been classified by the Panels as unsuitable for ordinary industrial employment, was 34,917. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 69,417; this was a decrease of 22,642 as compared with January 13th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 16,585, a decrease of 4089 as compared with January 13th. On November 25th last an analysis of the Wholly Unemployed Men's Register showed that 37·5 per cent. had been on the Register for less than four weeks and that of the balance 57 per cent. were fifty years of age or over. Assuming that these proportions still hold, there were, at February 10th, not more than approximately 50,000 wholly unemployed men on the Register who had been unemployed for more than four weeks and were under fifty years of age. The corresponding figures for women and girls at February 10th were 231,429 wholly unemployed, 44,818 temporarily stopped, and 1054 unemployed casual workers. As compared with January 13th, the numbers wholly unemployed showed a decrease of 30,997, those temporarily stopped a decrease of 15,504, and unemployed casual workers a decrease of 109. The table of divisional changes issued showing the difference between January 13th, 1941, and February 10th, 1941, in the total numbers unemployed on the registers in the various administrative divisions, shows that there was increased employment at all centres, the largest increases in employment being in the London, North-Western, and Scotland divisions.

Admiralty Control of Shipbuilding Labour

ON Monday, March 10th, it was announced that with the object of securing that the shipyards should make the best possible use of the available capacity, labour, and materials, with the greatest possible output, both in shipbuilding and ship repairs, the Government has decided that the First Lord of the Admiralty will henceforth be responsible for the most efficient use of labour in the shipbuilding industry. The organisation for controlling the industry will operate both at headquarters and in the shipyard districts. At the Admiralty the national control will be exercised by the Board of Admiralty. A small committee representative of the industry, consisting of two employers and two workers, will meet from time to time as occasion arises under an Admiralty chairman. In the shipbuilding and ship-repairing areas there will be set up local controls, under the flag officer in charge of the port, who, in turn, is responsible to the Board of Admiralty. For purposes of the control he will be given the title of District Shipyard Controller. Under the flag officer the local control will consist of three executives, representing respectively naval shipbuilding and repair, merchant shipbuilding and repair, and labour (normally the shipyard labour supply officer, who will be transferred to the service of the Admiralty). It is anticipated that controls will be instituted in the first place in the following districts, but this list is subject to revision:—Scotland (West Coast), Scotland (East Coast), North-East Coast, Humber, North-West Coast, Bristol and South Wales, London, Southampton and Cowes.

Birmingham Metallurgical Society

IN his Presidential Address delivered to the Birmingham Metallurgical Society on Saturday, March 8th, Mr. C. H. H. Franklin dealt with the progress of industry and its whither and why. He said that the keynote of the future must not be aimless achievement, but wide natural and harmonious growth. Making a plea for the establishment of a Science Museum in Birmingham, Mr. Franklin said that the Birmingham of the past, with its small and often ill-equipped garret workshops, was vanishing—that environment in which Boulton, Watt, and others laid the foundations for a vast industrial evolution. What record had we for our youth to see of the heritage from the past, which had become the background of their lives? London had its South Kensington; Liverpool displayed its shipping models; Sydney and Melbourne owned technical displays which showed us what we should have done. Where was the equivalent, with all the industrial growth of centuries to display, in the city that was once called the workshop of the world? Dudley, Hall, Siemens, Muntz, Turner, Dick, Elkington, Parkes, and others could be recalled, and records of processes and relics might and should be found and kept. When peace returned, surely it would be their duty to illustrate for posterity the way their life had grown to what it was, and, with display of the past, to provide models to explain the background of principle on which both craft and growth depended. What better work for skilled craftsmen in time to come was there than modelling a Ward or Archdale lathe, a Tangye engine, or Belliss set!

Royal Air Force Strength

IN presenting the Air Estimates to the House of Commons on Tuesday, March 11th, Sir Archibald Sinclair, the Secretary of State for Air, made reference to the growing strength of the Royal Air Force. He said that during the last ten months some 4250 German and 1100 Italian aircraft had been destroyed mainly by our incomparable air squadrons, while fewer than 1800 of our own aircraft had been lost. Our bombers, he continued, had made 260 raids on aerodromes and seaplane bases, 300 on docks and shipping, 470 on railways and communications, and 620 on industrial targets—all these in Germany—apart from the very many heavy raids on objectives in enemy-occupied territory. In addition, the aircraft of the Coastal Command had in the last ten months flown 16,000,000 miles. The work had included reconnaissance across the seas; convoy patrol; attacking warships, U-boats, and merchant vessels; and photographing and bombing enemy bases. Speaking of new types of aircraft, Sir Archibald said that later models of Spitfires and Hurricanes were now in service, fitted with more powerful engines which had considerably increased their speeds and provided the ability to fight at much greater heights, while heavier armament had increased their fire power. The new Hawker Tornado was equipped with engines of nearly twice the horsepower of the fighters which bore the brunt of the Battle of Britain, and could carry still heavier armament, and yet obtain speeds well in excess of 400 m.p.h. Other engines of as great or even greater power were coming on. Then in the twin-engine fighter types we had the Whirlwind, and for long-range fighter operations and for night fighting the Beaufighter, each with a very heavy armament. Of the bombers, the Hampdens, Wellingtons, and Whitleys had in the past constituted the R.A.F.'s main offensive armament. The latest models of these were fitted with more powerful engines which gave them increased performances and striking power. Some of them indeed, although the name remains, were really quite different aircraft. But these were being replaced by a range of very much heavier bombers, including the Stirling, Manchester, and Halifax. These bombers were more than twice the size of any earlier type. They were faster and carried not only a heavier defensive armament, but also three times the weight of bombs for the same distance as their predecessors. Sir Archibald also mentioned several types of American aircraft which had reached units of the Royal Air Force throughout the world. These included such fighters as the Brewster Buffalo and the Curtiss Mohawk and Tomahawk, the medium bombers of the Glen-Martin Maryland and Douglas Boston types, and heavy bombers of the Consolidated Liberator type, and the same company's P.B.Y. Catalina flying boats. Further American aircraft were now coming into service overseas, and in all four operational commands of the Royal Air Force at home.

Further Canadian Locomotive Experiences

No. I

By EDWARD H. LIVESAY

C.N.R., "THE CONTINENTAL LIMITED"

THE beginning of the century found Canada with one Transcontinental railway, the Canadian Pacific, having its western terminus at Vancouver. Notwithstanding the croakings of the Jeremiahs—"It will never earn enough to pay for the axle grease," and so on—it had confounded these pessimistic prophets by proving a great success, financially and in many other ways, and had acted as a vital link between the eastern and western provinces, which were widely separated, not only by distance, but by policy and outlook. Moreover, Canada was beginning to boom. Trade and industry were increasing by leaps and bounds, immigration had become a flood, and the future appeared golden. Therefore, it was looked upon as perfectly legitimate to mortgage it to the limit; a long and tragic story short, first one and then the other threw up the sponge, but as they could not be allowed simply to cease operation—too much and too many being dependent on them—the Government had to take them over, merge them into one system, and operate it under the name of the Canadian National Railway. So everyone was satisfied—except the taxpayer, who has had to foot a bill of some £200,000,000 spread over the last twenty years, and still dips into his pocket for additional millions annually. Still, as little Kaspar said, "Such things must be, after a famous victory." Canada has its three Transcontinental railways.

The average passenger travelling through British Columbia by rail sees little to differentiate the C.P. and C.N. routes. Perhaps the former has more fine scenery, but as the latter has quite enough, the particular, which is concerned with "The Continental Limited."

VANCOUVER TO SASKATOON

This train left Vancouver at 7.15 p.m. on a fine October evening bound for Montreal, 2929 miles, hauled by an oil-burning "Consolidation," 2–8–0, in charge of Engineer Meehan and Fireman Styles. This class of engine is used as far as Port Mann, because on this section there are two short pitches of 1 in 100, too much for the "Pacifics" that take over at that point. Incidentally, these are Great Northern metals, over which the C.N.R. has running rights, the latter company's line actually ending at Port Mann. The train consisted of eleven cars, weighing about 900 tons. These "Consolidations" have 4ft. 9in. driving wheels, 24in. by 32in. cylinders, 200 lb. steam pressure, tractive effort of 49,735 lb., and weigh 160 tons. They are freight engines. The first stop at New Westminster involved a restart complicated by a sharp curve and a rise of 1 in 100 on to the Fraser River Bridge. It was easily managed without slipping; 4 miles farther on came Port Mann, where the "Consolidation" made way for a booster-equipped

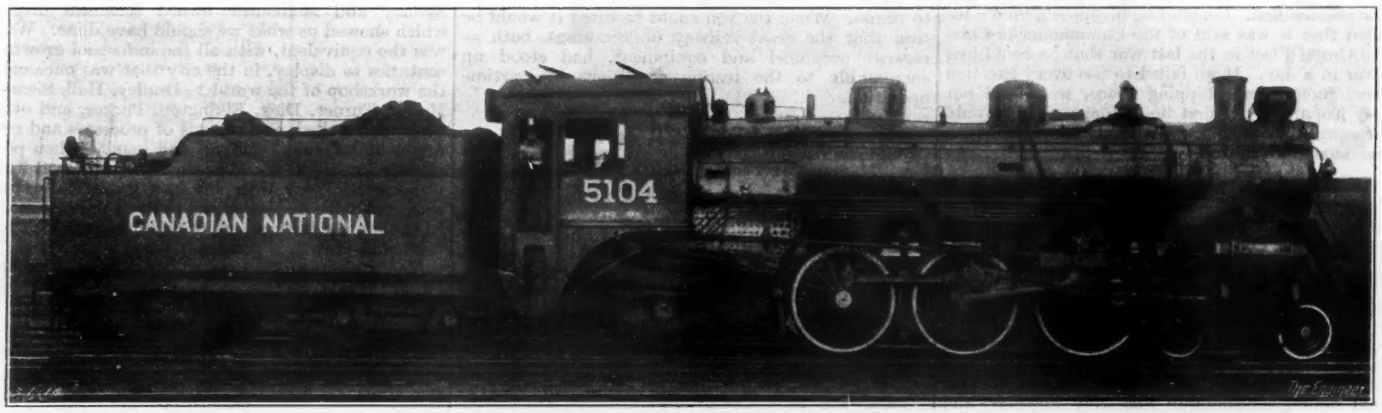


FIG. 1—C.N.R. "PACIFIC" J 4 CLASS LOCOMOTIVE

"expansion," "the development of natural resources" by "opening up the country," and many similar catch-penny phrases were in every gaping mouth, the product of every empty head.

One of the inevitable results of this reckless, unbalanced optimism was an orgy of superfluous railway construction that rivalled the Hudson "railway mania" of the eighteen-forties in England, and which had much the same result. One Transcontinental railway was looked upon as quite insufficient; the politicians and promoters said, "Let there be three"—and behold, soon there were three. Canada has never since ceased wishing there were not. It turned out that while one was a necessity, two were a luxury, and three insanity. From this railway-building spree there was a hangover that the country has even yet not recovered from, and is not likely to until the population becomes about 30 millions—it is now roughly 11 millions. So much for the Genesis of the three Transcontinentals.

The C.P.R. had made a tortuous and difficult way through the Rockies and Selkirks by way of the Kicking Horse and Rogers passes, but the Grand Trunk Pacific, the second aspirant for Transcontinental honours, chose a much easier gap in the barrier, considerably farther north, the Yellowhead Pass, and after threading this, continued westward to the coast, reaching tidewater at Prince Rupert. The third line, the Canadian Northern, also made the Yellowhead its right of way, but after getting through the mountains swung south-west down to Kamloops, from which point it continued side by side with the C.P.R. to Vancouver. It is with this third route that the present article is concerned.

Dare I say that "any fool can build a railway, but it may take a very clever man to make it pay"? When even he fails, as sometimes happens, bankruptcy results, and Government has to step in and pick up the pieces; so it was with the G.T.P. and C.N. Both had been built almost regardless of cost, with a wonderful gradient, in spite of the difficulty of the terrain, to secure cheap and easy handling of the great and ever-increasing streams of traffic that were expected to pour along them. But the Great War came, followed by depression—Nemesis, in fact. The flood of traffic never grew beyond a trickle, and finally the writing appeared on the wall. To cut anyway—what matter? But if the said passenger is really interested in railway operation, and keeps his eyes open, he will notice at least one decided contrast. The C.P.R. route from Vancouver through British Columbia to the prairie has very heavy gradients, calling for considerable double heading, whereas the C.N.R. has practically none, and double heading is unknown. The contrast is best seen from the vantage point of the engine cab, as it is here one is closest to fundamentals. A trip in the cab over the C.P.R. from Vancouver to Calgary, or *vice versâ*, leaves behind the impression of considerable stress and strain, whereas after a run to or from Edmonton over the C.N.R. one has a memory of easy-going, almost casual locomotive work, giving neither engine nor crew any real concern, the train jogging along hour after hour at a speed of 45 m.p.h. It is natural that this should be so, when one bears in mind that while the C.P.R. has many score miles of heavy inclination, some as severe as 1 in 48, as well as several "peaks" to surmount, the highest 5337ft. above sea level, the C.N.R. has but one "peak," at Yellowhead, of only 3717ft., attained from either side of the Rockies by almost constant but easy gradients, nowhere steeper than 1 in 100. It sounds almost incredible, but I believe there are roughly but 5 miles of this in the whole 517 miles from Vancouver to the Yellowhead Pass. In brief, the Canadian Pacific British Columbia route was comparatively cheap to construct, but is expensive to operate—the reverse is true of the corresponding C.N.R. division. (The reader should treat the words "comparatively cheap" with understanding and discretion.) This was illustrated rather graphically in February, 1929, when the collapse of a bridge in the Selkirks made it necessary to deflect C.P.R. main line traffic over the C.N.R., *viâ* Edmonton and the Yellowhead. When the C.P. trainmen saw the 38,000 lb. T.E. "Pacifics" that were to haul their trains through the mountains, their reactions were compounded of amusement and derision (one can easily imagine the sort of thing, typical of the way some railwaymen love to decry a rival company's motive power), which changed to amazement when it was subsequently proved beyond a peradventure that the despised "teapots" ("5100" class) had no difficulty in handling the trains. So much for topography; let us now proceed from generalities to oil-burning "Pacific," No. 5121—Figs. 1 and 2—with the following dimensions :—

"Pacific" Class J 4 (1919), C.N.R. (Fig. 1).

Cylinders	23½in. by 28in.
Valves (Walschaerts gear)	6½in. by 14in.
Driving wheels	5ft. 9in.
Heating surface—	
Tubes	2,521 square feet
Fire-box	267 ,,
Schmidt superheater	691 ,,
Total	3,479 ,,
Tube length	20ft. 6in.
Siphon and brick arch, feed-water heater (Elesco)	
Grate area	56·5 square feet
Steam pressure	200 lb.
Tractive effort—	
Main	38,100 lb.
Booster	9,000 lb.
Total	47,100 lb.
Factor of adhesion	4·54
Weight—	
On drivers	77 tons
On trailing truck (booster)	25 ,,
Of engine	124 ,,
Of tender	69 ,,
Total	193 ,,
Oil	2,800 gallons
Water	6,500 ,,

Cab arrangements were normal, with one exception. To the engineer's right, where he could rest his hand on it, was a small lever, connected to a swivelling headlight. Pushed forward, the beam swung to the left; pulled back to the right, and when released, both it and the beam returned to centre. This device enables the engineer to keep his beam bearing on the track, a very valuable safeguard where curvature is as frequent and sharp as is the case in British Columbia. This is one of those handy little gadgets that make one wonder why they have not been invented before. Superficial criticism will probably suggest an improvement—why not connect the headlamp with the leading truck? Unfortunately, this won't render, as they say in the Navy—it has been tried and discarded. It resulted in too violent transverse action, the beam jerking from side to side, and, worse still, it naturally could not anticipate a curve, the light shining off-stage just when it was most wanted. Only hand operation was really effective. Engineers become so used to working it that they "go through the motions" unconsciously, without their attention being called for or distracted.

On through Chilliwack and the Fraser delta, the continuous rise was so gradual as to be hardly perceptible. The starting point at Vancouver had been 14ft. above sea level, yet at St. Elmo, 84 miles, the altitude had only become 94ft. Here, however, the real climb, which reaches its culminating point at Yellowhead Pass, may be said to begin, as at Hope, 7·6 miles farther on, we were 157ft. up. There was little to be seen from the cab outside the area lit up by the white beam from the headlamp, registering on the track and picking out the frequent curves. Black mountain masses, sharply

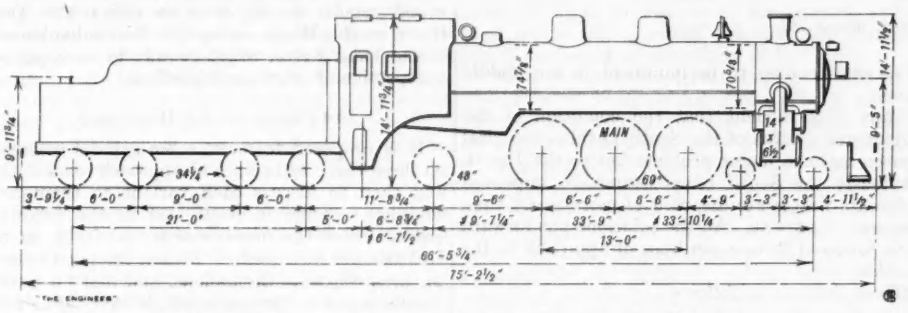


FIG. 2—DIMENSIONS OF C.N.R. "PACIFIC" J 4 CLASS LOCOMOTIVE

outlined against the greenish night sky; the glitter of moonlight on the wide Fraser River; an occasional twinkling light from a lonely cabin—these fleeting impressions and the cool night air, pure and redolent of the ubiquitous firs, are all that remain with me as memories of this section; my note book is a blank. The engine roared on through the night, until beyond Hope the first little tunnel was passed, and here, too, I had a momentary glimpse of an animal of some kind dashing across the track, seen for an instant in the glare of the headlight, disappearing into the darkness that walled us in. Meehan said he often saw deer, goats, and so on—even an occasional bear, which, he claimed, could run at 50 m.p.h. ahead of a train for a limited distance. Evidently a sprinter—it would have got away from us, as we were only doing 45!

Running along a shelf cut in the steep bank high above the Fraser, one looked right down into a lake of mist clinging like steam to the face of the waters, softening every harsh jutting crag and dimming distance, despite the flood of light from a full moon. The headlight cut a white tunnel through the shadow darkness ahead, shining on wet, glistening rock cuttings, and turning the nearby vegetation to a light, vivid green. It was all very absorbing, and my cup of happiness would have been full but for the fact that I was being slowly roasted. On this engine the third seat was in front of the fireman's, so I was wedged into a narrow and damnably hot slot between the rearward-projecting fire-box and the side of the cab. It seemed full of pipes, most of which were sizzling, and forced themselves upon me. Space was at a premium—one needed a shoe-horn to get into this seat, and two to get out. Finally, in desperation, to escape from this incinerator, I tactfully suggested that as it was difficult to see what the engine was doing from that point, or the gauges, perhaps I had better stand up at the back of the cab. It was true that seeing was difficult—I could only feel.

Hope was passed at 10.11 p.m.; the 75 miles from Port Mann, with one stop, had been covered in 131 min., 34 m.p.h. Still clinging to the Fraser, there, on the other side of the canyon, was the C.P.R., with a train gliding along it like a glow-worm, its headlight streaming before. Every now and then each of the rival trains seemed to hang back politely, and let the other go ahead, an optical illusion resulting from sweeping curves; first one would appear to be in front, then the other. The value of the swivelling headlamp was very evident along here, as the track was always lit up, and any obstruction, such as a fall of rock, would have been seen at once. The riding of the "Pacific" was good, and the oil firing gave a clean cab, and enabled the pressure to be held perfectly. The throttle position was about two-thirds and cut-off 25 to 30 per cent.

Night riding makes it difficult to take proper notes, as I have said before. This accounts for the moonlight effects getting so much attention! But it was all very lovely, and I cannot help saying so. At one moment the canyon would be in inky darkness, with the moon out of sight behind the mountains, and the train in black shadow; it would swing round a curve, and suddenly we would run out into a flood of clean white light, to see the silver globe riding calm and high in the pale green sky, pouring its splendour down into the great canyon, and over the swirling waters of the Fraser that flowed through it. Immensity—purity—cool mountain air; little torrents tumbling down from rocky heights, rushing under the track, and cascading into the Fraser far below; Hell's Gate, with the river foaming through, white and angry; and so into Boston Bar, the first divisional point, at 11.45 p.m., where the crews changed. The 131 miles of almost continuous climbing, with three stops, had been covered in 270 min., at 29 m.p.h. Altitude, 453ft., with nothing more than 1 in 100 anywhere.

Leaving Boston Bar at 11.55 p.m., things went on much as before. Still high above the Fraser, following its twists and turns, running through little tunnels and over bridges, all guarded by sentries armed with rifles that I hope they would use without hesitation if necessary. There is a war on! I made what notes were possible—which is not saying much—finding it easier to do so by the subdued light escaping from the gauge lamps, with the main lamp over the engineer's head switched off, as there was less dazzle. The engineer—I do not seem to have his name, which shows how sleepy I must have been—courteously switched it on whenever he saw me take pencil in hand, until I explained that I preferred to do without it. At Cisco the rival tracks changed sides, the C.P.R. crossing the river to the left bank and we to the right. Meeting a C.P. train in the canyon was quite spectacular. Far ahead a spot of light could be seen, appearing and disappearing at intervals as it entered a tunnel or was concealed by a shoulder of rock. Nearer and nearer, brighter and brighter, until finally the cavalcade of lighted cars would stream by on the other side of the canyon, a long pencil of white light blazing ahead. It was train No. 13, "The Mountaineer," *en route* to Vancouver, where it was due at 7.45 a.m. Lytton went by at 1.00 a.m., and I nearly abandoned ship; the Fraser was deserted, and the Thompson adopted; then came Spences Bridge, 2.00 a.m., and here, feeling sodden and dopey for lack of sleep, and that I was doing no good whatever in the cab, I retired to the train—a long blank appears in my note book. While comatose, Kamloops Junction was reached at 4.27 a.m., the second divisional point, where both crews and engines changed, a "6000" class, 4–8–2, taking over. The 126 miles from Boston Bar had taken 272 min., with four stops, 28 m.p.h. It does not sound impressive, but remember the conditions, the incessant curvature, the almost constant rise, and the load 900 tons. We were now 1153ft. above sea level.

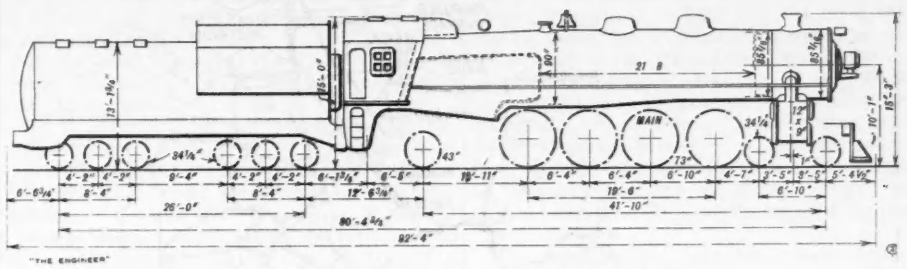


FIG. 4—DIMENSIONS OF C.N.R. 4-8-2 LOCOMOTIVE

"The Continental" pulled out of Kamloops Junction at 4.47 a.m., with a 4–8–2 "Mountain" type engine, "No. 6057"—Figs. 3 and 4—in place of the "Pacific." These engines are not used on the Vancouver and Kamloops section because their lengthy wheelbase is unsuitable for the constant curvature, and also I believe their weight is too great for one or two of the bridges. Their chief dimensions are given below:—

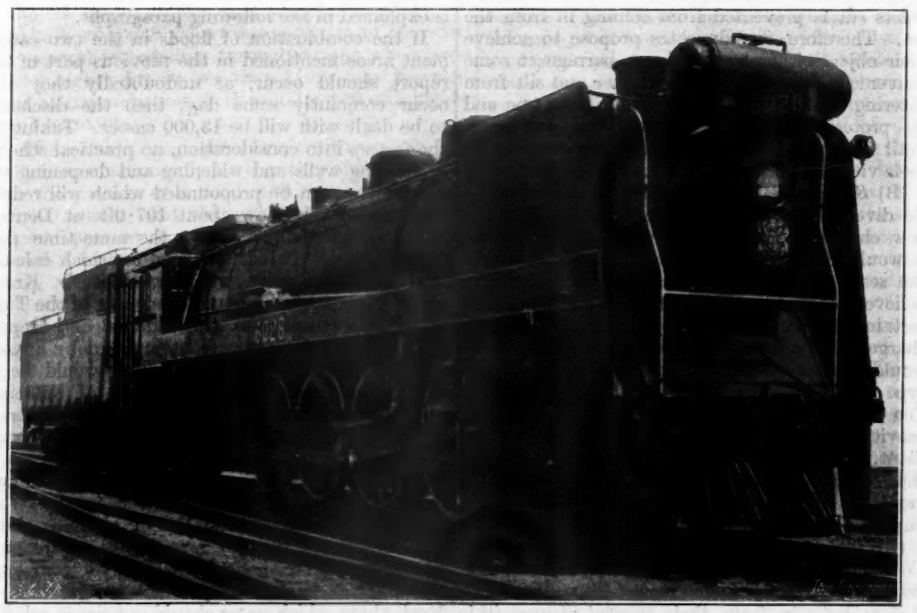


FIG. 3—C.N.R. U 1 CLASS 4-8-2 LOCOMOTIVE

Dimensions of C.N.R. U 1 Class, 4–8–2 Locomotives, Nos. 6047–58

Cylinders	24in. by 30in.
Valves—	
Diameter	12in.
Travel	9in.
Lap	1⅛in.
Lead	¼in.
Ex. clearance	1/16in.
Type of gear	Baker
Driving wheels	6ft. 1in.
Heating surface—	
Tubes	3,581 square feet
Fire-box	319 ,,
Schmidt superheater	1,040 ,,
Total	4,940 ,,
Steam pressure	250 lb.
Grate area	66·7 square feet
Weight—	
On drivers	103 tons
Of engine	158 ,,
Of tender	123 ,,
Total	281 ,,
Tractive effort	50,000 lb.
Tender (Vanderbilt)—	
Water	11,000 gallons
Oil	4,000 ,,
Or coal	20 tons

Two siphons, exhaust steam injector, multiple throttle.

Fig. 3, "No. 6028," shows coal tender and feed-

water heater, used on some of this class. Other details include " Nathan " mechanical lubricators, floating bushes to truck and main driving axles, and track sprinklers. They are fine engines, used on both passenger and freight service, and are employed from Kamloops right through the mountains and across the prairie to Winnipeg—and farther east still, I dare say. They burn oil fuel in British Columbia and coal on the prairie.

(To be continued)

Great Ouse Flood Protection

No. II

(Continued from page 161, March 7th)

Solutions for the South Level Problem

IT has been shown that the Middle Level is protected to a large extent against danger because many years ago the Upland waters were no longer allowed to flow through it, and because it pumps its own drainage into the Tidal River at St. Germans. In the case of the South Level the obvious advantage to cultivation of keeping out the higher water levels of the tides was no doubt the reason which impelled those interested to construct the Denver sluice.

While in practically all floods the water in the Ten Mile River system throughout the South Level rises higher than that which may be called the danger line, above which if the water rises there is danger of the embankments bursting, in especially high floods the water rises so high that the embankments are actually in danger of being overtopped. This danger would not arise if it were not for the fact that the level of the water in the Tidal River downstream of Denver sluice, and the water slopes in the Ten Mile River itself, regulate adversely the amount of water which can be discharged from the latter. Matters have been made worse by the certainty that high floods have increased in their peak volume in recent years. This effect is due to the clearing of channels in the Uplands, to the reduction in area of lands subject to flooding, and to better drainage, especially in the Lowlands.

The Hundred Foot River, the other main stream which joins the Tidal River at Denver, is affected by the state of affairs in the South Level. Retardation of the discharge of the waters from the Washlands, which are in reality the major part of the Old Bedford River below Earith, on occasions has been resorted to, the effect of such retardation being, of course, to lower the water level of the Tidal River at Denver. This lowering allowed of a better discharge of the Ten Mile River waters, and consequently helped to prevent absolute disaster occurring in the South Level. The objectionable aspect of retardation is that it may produce and, in fact, has produced in one recent instance, abnormally high water levels in the Washlands. These high levels endangered the Barrier Bank and consequently caused the risk of serious flooding to be imminent in the Middle Level.

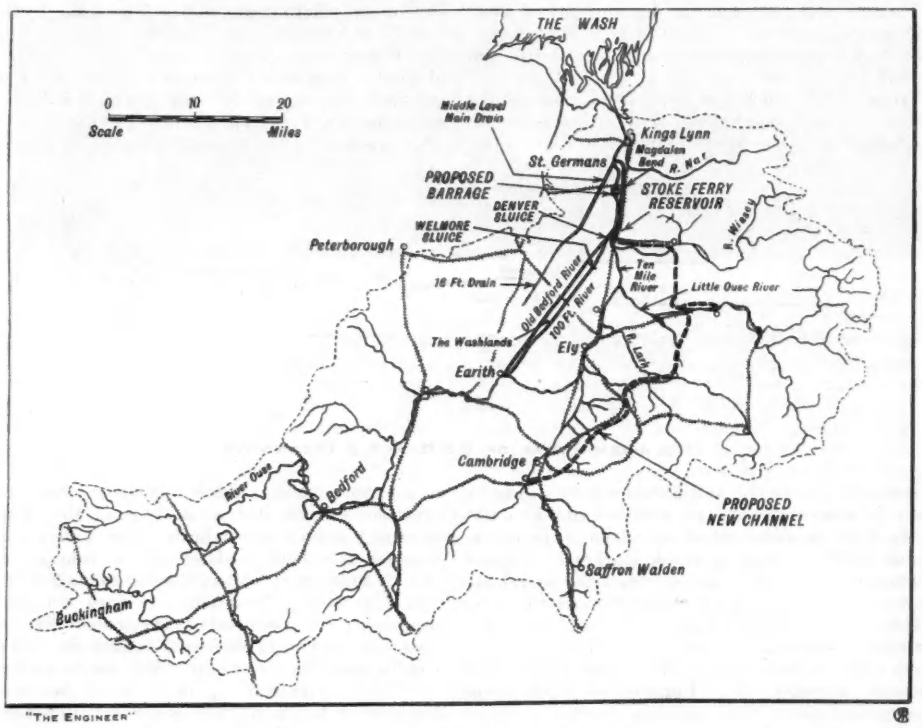
Thus it is evident that the condition of the endangered system of the South Level is the vital matter and the major problem before the Board. Obviously the South Level cannot be improved unless its waters are disposed of more easily than they are at present. All the solutions put forward have followed three main lines of approach to the problem.

These lines are as follows :—

(A) *First Method of Approach to a Solution.*—To widen and deepen the Tidal River to such an extent that the Denver sluice could discharge at such a low level that the Ten Mile River system and the South Level would be free from danger at all times. It is realised that widening and deepening cannot be adopted as a suitable measure unless silt is prevented from coming in from the sea. Therefore, its advocates propose to achieve their object either by erecting a barrage at some convenient point to keep salt water and silt from entering the channel, or to attain the same end by protecting the channel with training walls until it terminates in such deep water that, in their view, no silt can be expected to enter.

(B) *Second Method of Approach to a Solution.*—To divert the Ten Mile Water at Denver into a new channel parallel to the Tidal River, which it would only rejoin at some point much nearer the sea. The authors who adopt this principle believe that under such a scheme it could be made certain that the Ten Mile waters could be discharged in the time available, and at levels which would free the South Level from danger. In this type of scheme the water would flow from the Ten Mile River into the new channel either by gravity or with the assistance of a large pumping plant. No work would require to be done in either the Tidal River or the Wash, except on the embankments of the Tidal River, which require to be improved, irrespective of other considerations.

(C) *Third Method of Approach to a Solution.*—To remove the flood Upland waters now flowing through the South Level in the Ten Mile River system entirely from their present course (this was done in the case of the Middle Level) and make them flow in a new channel on the edge of the surrounding Uplands and thus protect the South Level for ever from danger. The portion of this new channel which extends from Denver to St. Germans would be very similar to that in the (B) schemes mentioned above. The drainage of the Lowlands of the South Level would be pumped as it is now into the Ten Mile River system, but when it reached Denver it would be pumped again, just as the Middle Level water at St. Germans, into either the Tidal River or the new channel, both of which at this point will be near the pumping station. No work would require to be done in either the Tidal River or the Wash, except on the embankments of the Tidal River, which require to be improved irrespective of other considerations.



MAP OF THE GREAT OUSE CATCHMENT AREA

Solutions to be Discussed

It is proposed to make some general comment on these three main lines of approach to a solution and then to discuss each variant to them as a complete scheme in itself and in the following order. After the improvements advisable in the Uplands are discussed, it is then intended to sum up these separate discussions, and make a recommendation as to the course which the Board should follow in dealing with its problems by the aid of one or more of these solutions :

A { (1) Mr. Kraaijeveld's Tidal River and Lynn deep project.
(2) Barrage at Free Bridge.

B { (3) Sir Alexander Gibb and Partners' parallel channel and large pumping station.
(4) Mr. Griffith's parallel channel and barrage at Magdalen Bend.

C { (5) Sir Murdoch MacDonald and Partners' cut-off channel.

General Comments

If there is no sand or silt flowing with the sea water the channel of the Tidal River can be excavated to any desired depth and width, without fear of such work being followed by silting, practical reasons concerning the magnitude, and the consequent cost, of the widening and deepening being the limiting factors. The effect of such work would be to give a bigger cross-sectional area to the channel and, as a corollary, the water would pass out to sea with a less gradient. Consequently, the water levels at the upper end of the channel would be lower. If a sufficient lowering of the flood level, tide out, at Denver could be accomplished by this means, then it is conceivable that a reorganised Ten Mile River could discharge its maximum flow, together with all the water which would accumulate behind Denver sluice during the period in which the state of the tide renders it necessary that the sluice should be closed. There would be, in such a case, no carry over of water in the Ten Mile River from one tide to the next. It must be noted, however, that such lowering of the level at Denver as is practically possible would not of itself form a complete solution to the South Level problems, as the water levels in a great part of the area would still cause them to be in almost as dangerous or disastrous a condition as ever they were on the occasion of the passage of a great flood. Why this should be so is explained in the following paragraphs.

If the combination of floods in the two catchment areas mentioned in the previous part of the report should occur, as undoubtedly they will occur conjointly some day, then the discharge to be dealt with will be 13,000 cusecs. Taking all the factors into consideration, no practical scheme of training walls and widening and deepening the Tidal River can be propounded which will reduce the water level below about 107·0ft. at Denver, when the tide is out, and at the same time pass a great flood. This is the level to which calculation shows the water would reach if Mr. Kraaijeveld's great widening and deepening of the Tidal River were completed. This widening and deepening is by far the largest contemplated by anyone and consequently any lesser work would be of lesser value. Any greater work of sufficient magnitude to secure a really effective lowering would be prohibitive in cost, even if Mr. Kraaijeveld's is not already considered to be so.

In these circumstances, when the maximum practicable works are constructed in the Wash and the Tidal River, and Denver sluice is closed to shut out the tide, the water level upstream of it would rise to about 111ft. and, of course, to some higher level at Ely. The danger line, or level, above which water should not rise in relation to its enclosing embankments in the South Level

has not hitherto been stated by anyone. It is therefore necessary that this danger line should be discussed and its level settled, its position being vital in any calculations of what works may be necessary or practicable.

It is understood that for many miles the top of the embankments in 1937 was about 112·5ft. Since then it is understood that £150,000 have been spent in remodelling these embankments. As a result the top level is now somewhat higher on the whole than in 1937. The cross-sectional areas are still small, but this has been compensated for partially by the provision in many places of a puddled clay wall to prevent infiltration as far as practicable. It is known that some lengths of the new work have sunk already almost as much as they have been heightened. This effect was to be expected where peaty embankments overlie peaty soil and an extra weight of material has been added to their top. Embankments repaired in this manner cannot be described as safe structures.

Water should never reach higher than a specified depth below the top of the embankments which contain it. In the circumstances of the case here being considered, it is suggested that the depth of freeboard should not be less than 2·5ft. on adequately dimensioned embankments, apart from any additional height to compensate for future sinking. That the high water levels reached in recent years were most dangerous as well as objectionable is a matter of common knowledge. Everyone is agreed that the water should never again be allowed to reach 112·5ft., and, if possible, it should be so reduced that it would only reach a point well below that level. An examination of recent longitudinal sections of the embankments shows considerable irregularity in their present top levels, but it is obvious, on the principle that the weakest link decides the strength of a chain, that 112·5ft. is still the regulating top level. A portion of the embankments is not now above it, a few lengths may be said to be at 113·5ft., and the remaining stretches of course are higher. If some additional work is done to raise the 112·5ft. lengths to 113·5ft., the latter can be taken as the top level of these embankments.

As most of the embankments, however, are built on a fair thickness of peat, they will sink. Therefore, an extra 2·5ft. of height ought to be provided to compensate for this effect over a period of time. If shrinkage of the peat proceeds, as it is reasonable to expect it will, at a rate of 1in. per annum, the embankments would require rebuilding thirty years hence, if no encroachment is to be made on the safe freeboard of 2·5ft. If 110ft. be taken as the danger line which water should not exceed with embankments at 113·5ft., there would only be 1ft. of an allowance for future sinking. With a 110ft. danger line the tops of the embankments ought to be at 115ft.—that is, there would be a safety margin of 2·5ft. at all times, and a provision of another 2·5ft. for future sinking over a long period.

All the embankments of the Ten Mile River system, which includes the Wissey, the Ouse, the Lark, the Cam, and various lodes should therefore be made up to a minimum of 115ft. if the water is to be allowed to reach 110ft., but even this amount of heightening it is obvious will cost a considerable sum of money. The data are not available to make a reasonably accurate estimate of the cost. A general remodelling throughout the whole area for a higher danger line than 110ft. may be ruled out as impracticable as it would entail still higher embankments.

The conditions, therefore, with which all solutions must comply are that they should provide for the passage of a flood with a peak volume of 13,000 cusecs, and that while passing this they should prevent the flood water, anywhere in the South Level area, exceeding 110ft.

In these circumstances calculation shows that the (A) schemes envisaging works on the Tidal River and in the Wash, even if the latter proved successful in excluding silt, a matter which no one can predicate, would fail to improve conditions in the whole of the South Level, and they would still be unable to do so even if accompanied by heavy works in the Ten Mile River system. Calculation also shows that the (B) schemes for a parallel channel from Denver to some point downstream of it would fail to make any material improvement in the existing conditions from near Ely southwards—that is, in a large part of the South Level area these schemes would not reduce the flood water level below the danger line, even if accompanied by heavy works in the Ten Mile River system. The (C) scheme would entirely relieve all parts of the area of the South Level. Never again need the water be allowed at any time even to approach the danger line of the existing embankments at any point, but on all occasions it would be several feet below it.

It must be noted that the two schemes put forward under (B) and the (C) scheme would continue to work without the expenditure of any money on works to increase the carrying capacity of the Tidal River, or on other works in the Wash either now or at any future time. The fresh water flowing down, under the conditions in which these schemes (B) and (C) are designed, would for ever keep a channel clear to the sea at the present average bed levels and it would discharge the maximum flood envisaged as ever likely to flow down.

Thus it can be seen that training works in the Wash (even if successful) alone cannot solve the South Level's problem. Their principal function is simply to endeavour to stop the entry of silt.

Works in the Tidal River are only possible if works in the Wash prove successful. These Tidal River works, as pointed out, have limits set to their magnitude by their cost. For calculation purposes the largest channel contemplated by anyone for the Tidal River has been used and regarded as the limit. A still larger channel, if the works in the Wash were successful in excluding silt, would be more effective, but the cost would be great. Works in the Wash and the Tidal River conjointly, if silt be successfully excluded, cannot solve the problem. The maximum improvement practically possible would not free a very large part of the South Level from danger. Works in the South Level by themselves cannot solve the Board's problem. These works also have a limit set to them by their magnitude, their cost, and their practicability. If, in addition to works in the Wash and the Tidal River, there be added such works in the South Level as are practically possible, even such combined works cannot collectively reduce the water level so that it does not exceed the danger line of 110ft. everywhere in the South Level.

[At this point the report deals with the details of individual schemes. The first to be mentioned is Mr. Kraaijeveld's.]

Mr. Kraaijeveld's scheme consists of (*a*) the construction of a channel between training walls from West Beacon to Hull Sand Beacon; (*b*) and (*c*) the dredging of the Tidal River and the construction of a bank protection on both sides of it from a point 2 miles above Denver sluice to West Bank Beacon; (*d*) the construction of a sluice (with lock) in the Hundred Foot River, 2 miles above Denver sluice; (*e*) the dredging of the Hundred Foot River and the construction of new dykes on both sides of it.

A barrage at Free Bridge is then examined. Sir Alexander Gibb's, the next proposal to be considered, is that a large pumping station should be erected at Denver to lift the water from the Ten Mile River in times of flood into a new channel to be dug parallel to the Tidal River on its east bank, from Denver to Magdalen Bend. At this point the water would flow by gravity through a sluice into the Tidal River, as the levels of the tides permit.

Mr. Griffith's scheme is next discussed. Mr. Griffith proposes that a new channel be cut parallel to the Tidal River between Denver and St. Germans, a distance of 9¼ miles. On those occasions when the flood waters of the Ten Mile River would rise above a certain level at Denver they would be diverted by closing the Denver sluice and opening a sluice into the new channel. Thus, in reality, the new channel would form a prolongation of the Ten Mile River. When the tide fell to the appropriate level at St. Germans the waters so diverted would be discharged through a regulator into the Tidal River at that point. This regulator would act in a similar manner to the Denver sluice and, like it, would exclude the tides. The new channel as designed would not have sufficient storage capacity by itself to lower the water in the Ten Mile River to the desired level. Mr. Griffith therefore proposes that about 700 acres in the Stoke Ferry Fen near Denver—see map—should be turned into a reservoir or, to use the common term, Washlands. Mr. Griffith also proposes that a barrage of the intermittent type should be built across the Tidal River in the middle of the proposed new short cut which would straighten the river at the Magdalen Bend—see map. This barrage is an integral part of his scheme. His view is that with the barrage in existence he would keep the water back in the channel upstream of the barrage by closing it at the moment of full tide and keep it closed until there was a few feet of head on the structure, and then release it. The water, with this added head, would have an increased scouring effect. This could be done every tide, if necessary. He expects this action would lower the bed of the river both up and downstream of the work, with consequential benefit to the Hundred Foot River and its Washlands.

Finally, the report deals with Sir Murdoch MacDonald and Partners' scheme.

The ideal solution, and it is that adopted in this scheme, is to repeat the principle laid down by the Romans and divert the Upland water, round the edge of the Fens, into higher and more solid ground in an entirely new channel, hereinafter called the cut-off channel, which eventually would join the Tidal River at St. Germans. The Ten Mile River system in this scheme no longer would carry the Upland floods through the heart of the South Level, but only the local drainage and any other water required to preserve the existing amenities, such as navigation, irrigation, &c. The water from the Ten Mile River would be pumped into the cut-off channel at a comparatively small station at Denver working only during heavy floods. Thus safe and low water levels would be maintained both now and for all future time throughout the whole of the South Level.

The line of the new channel is shown on the map. It begins at Grantchester, just upstream of Cambridge, and passes near Mildenhall, Wilton Bridge, and Stoke Ferry on the way to Denver. From there it runs parallel to the Tidal River and discharges into the latter at St. Germans, where the wide Eau Brink begins. At the end of the cut-off channel at St. Germans there would be a regulator to exclude the tide, and the silt which the tide carries. As the cut-off channel would intercept the rivers and lodes at the points where they leave the Uplands, it is necessary to make it capable of passing the estimated peak flood discharge—6300 cusecs—from Denver to St. Germans. During the period of high tide the flood waters coming down the cut-off channel would be stored temporarily in the channel itself and in the Stoke Ferry Fen reservoir proposed by Mr. Griffith, and mentioned in the note on the works which he proposed. The utilisation of the Fen as an adjunct to the scheme permits of a narrower channel from Denver to St. Germans than would otherwise be necessary to store the water coming downstream while the tide is flowing up, and the sluices closed against it.

The cut-off channel, from Denver to St. Germans, would be used only during high flood conditions, and the water from the cut-off upstream of Denver flowing round the edge of the Fens, ordinarily would discharge into the Tidal River at Denver, and thus continue the scouring of silt as it does at present in the Denver–St. Germans reach of that river. With the calculated maximum flood flowing in the cut-off channel and into the Tidal River at St. Germans, the low water level at the latter point would be raised from 99ft. to 102ft. as a maximum. Notwithstanding this change in level at the peak of a flood there would be no change in the average height of pumping from such stations as the Middle Level at St. Germans, the same amount of water going down the Tidal River, below St. Germans, as before.

In the Tidal River it is estimated that the backwater curve due to the peak flood conditions at St. Germans would not raise the maximum water level at low tide at Denver above 110ft., which is the maximum under present conditions. The Washlands consequently would be able to discharge freely and there would be no need to regulate on Welmore Lake sluice. This would obviate the acute conflict which now exists between the need to discharge the Ten Mile River at Denver and the Washlands at Welmore in times of flood.

Regulators would divert the flood waters from the rivers into the cut-off channel. In the same manner flood waters from the Lodes and other streams would be led into it.

The advantages inherent in this scheme would be that none of the flood waters from the Uplands would flow through the rivers of the South Level; the existing rivers as they cross the Fens would become ordinary drainage channels carrying only the local pumped water and as much of the Upland water as the Lowlands require for special purposes; safe conditions would be maintained automatically at all times throughout the whole of the South Level, which would be relieved of all danger from breaches in its river embankments, and this would be the case both under present conditions and also when the Fens sink to their lowest

levels in the future; no enlargement of the Ten Mile River would be needed, and maintenance of the existing embankments would be reduced to a very minimum if not absolutely abolished as an item of cost; no alteration would be required in the water section of the Tidal River.

It is recommended also that the barrage, which Mr. Griffith proposes, should be built in the Magdalen Bend cut. This would control the level of the bed of the Tidal River and allay any anxiety on this point. This barrage would also control the level of high tides upstream of it.

Summing Up

Having examined all the schemes and suggestions put forward as solutions of the major problem centring round the inability of the Tidal River as the outlet of all the waters in the Board's area, so to function that danger or even disaster within the area may be avoided, the position in regard to these solutions may be summed up as follows.

Mr. Kraaijeveld's Scheme.—Although the author does not say so, this scheme is based on the probability that the works would keep out silt, which must be a matter of doubt. Even if it were successful in attaining this object the objectionable and dangerous water levels in the South Level would not be reduced appreciably under the flood conditions envisaged. The scheme is also much more costly than others which will give greater benefit.

Barrage at Free Bridge.—Except for the probable silting in the Marsh Cut mentioned below, an ordinary barrage at Free Bridge and a widening and deepening of the Tidal River above it would achieve about the same small improvement possible under Mr. Kraaijeveld's scheme, provided that the latter proved successful in keeping out silt, and it would do it at far less cost. It is believed, however, that as a result of the working of the barrage, silt would accumulate downstream. It is very difficult to say to what extent this would happen; but it is felt that it would occur to such a degree as to vitiate any benefit which would otherwise accrue from the construction of the barrage. On the ground of this probable silting the scheme would be opposed by the King's Lynn Dock Company, whose property is a short distance below the site of the proposed structure. Even if this silting did not occur the scheme would have no appreciable effect in reducing the dangerous flood levels in the South Level.

Sir Alexander Gibb's Scheme.—If this scheme were adopted a great improvement would take place in the water levels of the Ten Mile River at Denver, where the maximum level would be lowered from 112·5ft. to 107ft. The water levels in the neighbourhood of Ely and beyond would not be appreciably lowered. The need to regulate on Welmore Lake sluice and to hold up water on the Washlands in order to assist the South Level would never arise. The whole of the flood waters from the Uplands would continue to flow in the Ten Mile River system and thus pass through the heart of the South Level. Where on peat the embankments would sink. This would necessitate the rebuilding of them at intervals of, say, thirty years, until the sinking was completed. An annual cost would be incurred in maintaining and working the large pumping station, although, in fact, it would only be worked during heavy floods. The general principle of the scheme is undoubtedly sound, yet as shown it is only a partial solution of the major problem before the Board. It cannot give effective benefit to the southern half of the South Level.

Mr. Griffith's Scheme.—This is preferable to Sir Alexander Gibb's, in that it would do all that his would do, and at the same time avoid the erection and occasional working of a large pumping station. It is subject to the same disadvantage as Sir Alexander Gibb's in that it cannot give effective benefit to the southern half of the South Level.

Sir M. Macdonald and Partners' Project.—The cut-off channel from Grantchester to St. Germans is the scheme recommended. It is the ideal complete solution of the major problem, namely, the danger of flooding in the South Level, which, as explained, has repercussions on other parts of the catchment area. If the Board cannot undertake the whole of this project immediately, owing to its cost, even although it is much less than that of the Wash scheme, it is recommended that the portion of the channel from Denver to St. Germans should be constructed. This would greatly reduce the water level in the Ten Mile River near Denver. If it is not expected that the upper portion of the cut-off channel from Denver to Grantchester can be carried out in the near future, then, in addition, it is recommended that Mr. Griffith's widening of the Ten Mile River at a cost of £180,000 should be carried out. This would be of advantage in that it would produce a small reduction of flood levels in the neighbourhood of Ely.

Summary of Estimates.—A summary of the estimates of the different schemes, adjusted so as to comparable, is as follows:—

	£
Mr. Kraaijeveld	5,200,000
Barrage	2,260,000
Sir Alexander Gibb and Partners	1,240,000
Mr. Griffith	1,296,000
Sir M. MacDonald and Partners	3,460,000

Uplands' improvements are required, no matter which of the above schemes is adopted, and are estimated to cost £350,000 additional to any of the schemes.

The River Great Ouse Catchment Board has brought to our attention an error in the introductory paragraph to this article which appeared last week. We wrote "in April of that year the Ministry of Agriculture appointed Sir Murdoch MacDonald and Partners . . . to formulate a scheme in conjunction with the River Great Ouse Catchment Board. . . ." The Board informs us that Sir Murdoch MacDonald and Partners were appointed solely by the River Great Ouse Catchment Board on May 12th, 1939.

Obituary

RALPH DAVID GIVEN

We regret to have to announce the death, on February 28th, of Mr. R. D. Given, head of the industrial engineering department of the British Thomson-Houston Company, Ltd., Rugby. Mr. Given was born in Musselburgh in 1882 and was educated at Daniel Stewarts' College, the Heriot Watt Technical College and Edinburgh University, graduating in April, 1907. He gained a Whitworth Exhibition and won the Watt Club silver mdeal for engineering subjects. Before commencing his University training he served a six years' apprenticeship in mechanical engineering at the works of James Bertram and Son, Ltd., Leith, and the early experience thus gained with papermaking and similar machinery proved very valuable in later years when developing B.T.H. electric drives for paper mills, &c.

After his University training he spent two years with W. H. Allen, Sons and Co., Ltd., Bedford, on the design of high-speed engines, electric lighting plant and pumping plant. In 1909 he went to South Africa to join the staff of the Central Mining and Investment Corporation, Ltd., Johannesburg. There he became chief draughtsman and gained some valuable experience in the electrical and mechanical engineering equipment of the gold mines, as well as in the design of winders, haulage gears and all kinds of mining plant. This experience was of great value to him later when carrying out design and development work at Rugby on electrical equipment for mines.

On returning to England in June, 1913, he joined the staff of the B.T.H. Company, in what was then known as the power and mining department at Rugby. That department developed into the industrial engineering department, and Mr. Given, as chief of the department, used his wide experience in solving many difficult problems relating to electric driving in industries such as mining, rolling mills, papermaking, &c.

Mr. Given was a Past-President and active member of the Rugby Engineering Society and will be greatly missed by his many friends in the B.T.H. organisation and the engineering world.

Literature

Jane's Fighting Ships, 1940. Edited by Francis E. McMurtrie, A.I.N.A. London: Sampson Low, Marston and Co., Ltd., 22, Essex Street, Strand, W.C.2. Price three guineas net.

The 1940 edition of "Jane's Fighting Ships," that indispensable book of reference on all matters relating to naval warfare, was published on Wednesday, March 5th. The publishers had hoped to bring out this issue earlier, but circumstances arising from the war made its date of publication considerably later than usual, owing to difficulties which arose chiefly in connection with the illustrations. We are informed by the publishers that it has been necessary to dispense with one or two illustrations, but our inspection shows that there is much new matter in the volume, and that the number of photographs, plans and silhouettes compares well with those of recent issues. In the early part of the book, for the first time since 1919, a War Loss section has been introduced. Considering the absence of accurate and complete information as to enemy losses, the lists of vessels sunk or damaged is, up to the time of publication, surprisingly complete. There has been no appreciable change in the size of "Jane," although the Loss Section occupies seventeen pages. By carefully revising the make-up the editor has found it possible even to reduce slightly the actual number of pages, without, however, taking out useful information.

From the particulars of the construction programme of the naval powers of the world it would appear that, after making allowances for the assumed completion of certain ships, the total number of capital ships now under construction or on order is not less than forty. If the tonnage of four Japanese battleships of the "pocket battleship" type be excepted, then all these ships have a displacement of at least 35,000 tons each, while twenty, if not more, are of 40,000 tons or over. For some of the new American battleships a displacement of 52,000 tons has been suggested.

In time of war it was not to be expected that many new facts and figures would be permitted to appear in the British section, as all possibility of giving any help to the enemy must be avoided. New material does include, however, a clearer plan of the "King George V" class of battleships, the value of this drawing being enhanced by placing a scale below the profile view, a practice which has been experimentally tried in the drawings of some other outstanding vessels. New figures now published for the first time show that the length of the battleships is about 739ft. 8in., with a beam of 103ft. and a draught of 27ft. 8in. The latest type of aircraft carrier, H.M.S. "Illustrious," is shown, as is also the new type of light destroyer of the "Hunt" class, which ships were formerly rated as escort vessels. Some rearrangement has been necessitated by modifications in the official classification of certain warships. In the French section the editor has retained this year for purposes of reference only the programme of new construction which in recent years was put in hand in French shipyards. It is not expected, however, that most of this tonnage will ever be completed. Many ships nearing completion or just launched from Atlantic yards were blown up before the enemy occupation, and the 35,000-ton battleship "Jean Bart," which was afloat and in course of completion, was taken to Casablanca, where there are no facilities for finishing her. Apart from those ships which are operating with the Royal Navy as part of the Free French forces, other French naval vessels are immobilised or are laid up at Alexandria and in the West Indies, while the remainder are at Toulon, Casablanca or Dakar. It seems doubtful whether the two battleships "Dunkerque" and "Provence," which were heavily damaged in the British attack on Oran, will ever again be fit for fighting service.

Some new pictures of German ships are given, but there is evident difficulty in securing reliable information both as to losses of ships and U-boats and the completion of new units. Doubt is expressed at the reported completion of the two German battleships "Bismarck" and "Tirpitz," and it would seem to be more likely that only the "Bismarck" is ready for service. Another uncertainty is the type of ship to which the name "Deutschland" was given when the pocket battleship of that name was renamed "Lutzow." The view accepted is that the balance of probability is that the name "Deutschland" has been assigned to the second aircraft carrier of the "Graf Zeppelin" type, rather than to the third battleship of the "Bismarck" class.

New additions have been made in the Italian section, notably to the battleships of the "Littorio" class, and various smaller vessels. There are welcome additions in the Japanese section, and it would appear that two or three Japanese battleships, over 40,000 tons, and an equal number of pocket battleships were launched in the period 1939–40, while cruisers, destroyers and submarines were being completed. The large American construction programme receives adequate attention, and the opinion is expressed that owing to its size and the busy state of United States shipyards it will probably not be found

possible to lay down all the ships authorised before the end of 1941. Each of the smaller navies is generously treated and although the official secrecy with regard to developments in the Soviet Navy has not been lifted, nine new photographs and a good deal of new information appear in the Russian section.

Mr. McMurtrie expresses his thanks to many voluntary helpers, without whose work, with that of the various Naval Attachés and representatives, he could not in an extremely busy year have presented such a full account of naval developments. If we might be permitted to make a suggestion, the general index might be better placed. In this year's edition it is difficult to find. We would congratulate both the editor and the publishers on producing under difficult circumstances an issue which carries on the highest traditions of "Jane's Fighting Ships."

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

A "GO AS YOU PLEASE" TECHNOLOGY

SIR,—During recent attempts to give students a better understanding of the mechanical properties, their relationships, and the means by which metals become endowed with them under various treatments, I have been taking renewed interest in the standard works, and in all available references to these burning questions for engineers and metallurgists.

As one of those who have sought to put together a systematic and connected framework of salient features, I confess to dismay at the untidy state of the technology of mechanical properties, and at the complacency of engineers and metallurgists in this respect. The terminology has expanded along the casual lines of a "ribbon development." There is some conflict of ideas between the original conception of a property, or its commonplace definition, on the one hand, and the logical meaning of the test figure supplied to represent that property, on the other hand; and, moreover, we seem to have dreaded the formulation and expression of undeniable principles to apply generally to simple cases merely because complexities and exceptions are legion.

The subject is surely overdue for a general renaissance which should speed technicians all the faster towards more wonderful results. To demonstrate some of the possibilities, I beg leave to offer a few suggestions covering the subject but superficially:—

Terms, General.—Those properties which are, in fact, stresses might without exception be so described, discarding the word "resistance" where it is a stress (as in "creep resistance") or where it is an energy (as in "shock, or impact, resistance"). "Ultimate tensile stress" is, of course, a misnomer, for which "apparent maximum stress" should be substituted. We do not make any easier the understanding of the hardness test by calling its result a "number" instead of a stress as it really is. "Shock" or "impact" (resistance) is misleading, since the test, originally purporting to cause fracture by the swiftness of the blow, has been found to have a somewhat different character which these expressions tend to mask.

In time it might be possible to systematise the terminology by the use of suffixes to denote the units of measurement.

Strength.—Discussion and understanding will continue to be seriously handicapped as long as a cardinal word like this is used both in the unrestricted sense, and also in the restricted sense as a term. As a term, "strength" should stand either for apparent maximum stress, or for real maximum stress—not for both. But all too often it is used to stand for some personal, otherwise indescribable, *feeling* about a metal, and since this feeling is largely a matter of individual experience with metallic materials, there can be no real community of ideas between those who employ the word thus. The difficulty is the greater when reference to "strength properties" and to "endurance strength" are made, using "strength" in the widest possible way to mean little more than "reaction."

Toughness.—This is another word which is employed by far too many in arduous and foredoomed attempts to convey some individually conceived notion about a metal. When we enjoy a more lively and inspiring leadership in these matters, the majority now adopting ca'canny attitudes will join the minority who have been adventurous from a necessity to come to grips with the subject. To such a minority the following is found to be of great value in illuminating a wide area; throughout the literature it is to be picked up in bits and pieces, large pieces being discovered on rare occasions; but as a rule, it is not completely stated, and it is not generally taught:—

"Toughness" is a word required as an essential term to mean the energy in foot-pounds to fracture a certain test piece in a certain machine. The Izod type of machine neatly and automatically registers those foot-pounds, but a sharply *notched* test piece distinguishes between metals in this test according to a *notch-toughness* rather than according to an ordinary toughness. A very bluntly notched test piece would cause the fracture to be where it is wanted for the sake of uniformity of test conditions, and would permit the registration of ordinary toughness. It seems that the speed of loading to register these ordinary toughness energies can vary so widely without vitiating results that the results obtained in the fairly slow tensile test (the area under the stress-strain curve is the energy to fracture) are comparable with those of the Izod type "shock" or "impact" tests, but not with those obtained from tests employing much slower or much faster loading. (N.B.—A fine notch gives rise to excessively high local loading speed.)

Hardness.—Before we can enjoy the satisfaction of having mentally embraced the subject even as to crude essentials, the property of hardness should be much more sharply focused. Two foggy areas seem to blanket hardness, so that the majority have never had a very clear view.

The first is the fog of hesitation or over-caution, which has withheld the announcement of a vital generalisation, namely, that loading of all types, even of mixed types, is opposed *in but one way* by metals—by shear opposition at the crystal gliding planes throughout the metal—much as though all attacks from outside, whether by tanks, aeroplanes, artillery, or bayonet charge, were invariably met and opposed inside by the "square" of infantry. A grasp of this fundamental idea will show that tests of metals by different types of loading should not differ in reality, and only appear to do so for simple reasons. So that a hardness test, as carried out by a (mainly) compressive loading to the fracture of some of the metal, cannot differ from a tensile or any other test in respect of registering a different type of metallic opposition—for there is but one type. In what respect, then, does this hardness test differ from, say, the tensile test?

And so we come to the second fog patch which has been allowed to collect round the fundamental matter of the *true* stress-strain curves, the curves corrected for the necking of the tensile specimen, for the bulging of the compressive specimen, and for the relevant change of shape during test of specimens fractured by shear or by mixed types of loading. Can anyone who has taken thought along these lines believe in the existence of differences between these real curves corrected for both stress and strain?

There seems to be a veritable conspiracy of caution with regard to these essentials. Why do we not hear more of Lueder's lines? Why do we not see more of the true curves? Taken together and to their legitimate conclusions, they surely throw a flood of light!

When we break through these mists we should surely be able to draw the simple inference that the hardness test is merely one which *automatically* registers the *real strength*, a property not automatically registered in the tensile test, but which can only be obtained from the latter by calculation with the load and the cross-sectional area. The value of the hardness test lies in its simplicity and in its direct reading character; apparent maximum stress can be estimated from it. In rather the same way, the Izod and similar tests, giving direct readings for energy to fracture, are preferred to the indirect estimates of toughness which can be obtained by calculation from the area under the curve of the tensile test diagram.

The Stress-Strain Diagram.—At the present stage the majority of engineers and metallurgists are barely alive to the potential danger of their dual outlook on some of the properties; they know ductility, for example, not only by its definition (which they can no doubt reconcile with their personal feelings about that property), but also by the test which supplies the quantitative estimate for use as the "legal tender" throughout the world. Now, unless they have given the matter thought from this particular angle, they may not have realised that the ductility of their definition or of their conception differs from that of the actual test in some important particulars. In discussion they will be found to muddle their dual outlooks upon the same property in an utterly disconcerting manner. The definition, together with a little original but pardonable imagination, might seem to suggest some *ease* of drawing out, whereas the test of ductility is just the percentage elongation of the 2in. test piece, in no way implying ease or difficulty of drawing out, and implying no die drawing, of course. In much the same way, the common conception of strength, and the too-easy interpretation of the test for it, have been so satisfying and useful up to a point that they have really masked the truth about the behaviour of metals, and given rise to endless misunderstanding.

Therefore it is of the highest importance to describe and reason on the stress-strain diagrams alone, forgetting as soon as possible all those ideal qualities and definitions which have been respectively abandoned and ignored by the actual tests we have applied. It does not really matter to engineers and metallurgists that ductility can be described for the benefit of non-technical friends as the property by which a metal may be drawn out! If we despatch to the ends of the earth a quantitative estimate of ductility, it is the percentage elongation we send; and hence for us ductility is little else than the lateral extension of the stress-strain curve, and we earnestly hope that the same idea will be conveyed to the remote recipients of our estimate.

On the stress-strain diagram most of the mechanical properties disport themselves for all to behold and to examine in their relationships:—Apparent strength, the maximum height of the common curve; real strength, which is hardness, the maximum height of the true curve; ductility, the horizontal extension of the curve; toughness, the area under the curve; the hysteresis loop (which ultimately brings disaster upon the fatigue test specimen) is clear enough when the compression curve is entered into the third quadrant.

Notch Toughness and Creep Resistance.—As to these, I suggest they belong not to the flat stress-strain curve, but to a three-dimensional model of it in which the third dimension refers to the speed of loading, or else to the maximum stresses induced. If this diagram is difficult to visualise, at least we can remember that the mechanical properties of metals (as we know them from tests within a certain range of loading speeds) are different when tested at speeds of loading *on either side* of that range.

For it is recognised that at certain very low speeds, as also at very high loading speeds, the shape of the stress-strain curve differs from that of the usual curve in the sense of exhibiting less strength with more ductility at low speeds and more strength with less ductility at high speeds. All metals are not equally affected by load speed variation; hence it is possible to distinguish between metals according to their property of resisting this prevalent effect of the raising of the loading speed (*notch toughness*), and also according to their property of resisting the prevalent effect of the lowering of the loading speed (*creep resistance*).

To make this point I am assuming that at a fine notch a very high local loading speed is to be expected as a constant factor causing the display of low fracture energy if the metal's strength rises much, and of high fracture energy if it rises but little—presuming that toughness (the strength-ductility product) is the greater at the lower strength, as is usually the case.

Summary.—To summarise very lightly, it seems that we could do much to tidy up this technology if we were to tighten up on terms, keeping them short, unequivocal, and purposeful, and condemning to oblivion all those words implying anything or nothing, according to individual taste or the exigencies of the argument! Preconceived ideas or innate feelings on the properties must be closely analysed and freely abandoned if they prove to conflict with the meanings given them by our tests; for it is the test which is the criterion of the property, since the test figure is the legal tender for the whole world of engineering and metallurgy.

However we may be temporarily baffled by complexities which probably arise from differences in microscopic and sub-microscopic structures of the metals, we should not be over-cautious in founding and teaching a technology of mechanical properties based upon a forthright and logical interpretation of the knowledge we already have. This may only apply to the simplest case, but it is just this framework we so sorely need in order to face the exceptions and to fit the whole jig-saw together.

After all, the immensely valuable edifice of electrical technology was erected without the least idea what electricity itself was, and subsequently all the invaluable strides in the radiation of electrical energy assumed a medium which simply is not there! Need we demur?

A. C. VIVIAN,
Flight Lieutenant, R.A.F.V.R.

March 11th.

AN AVIATION SCHOLARSHIP.—The foundation of a scholarship in aviation for a woman is proposed as a memorial to Miss Amy Johnson. A fund has been opened by the Women's Engineering Society, 20, Regent Street, London, S.W.

The Engineer

MARCH 14, 1941

VOL. CLXXI No. 4444

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THE NAVY AT WAR

IN the early months of the war we were all heartened by the periodical review which Mr. Winston Churchill gave of our exploits at sea. But as time passed the opposition of naval officers to the publication of results gained strength. A veil of secrecy was dropped over the sea war, and only lifted when the Service was satisfied that the enemy could not gain any useful information from the published accounts of naval activities. There are good grounds for believing that the policy, disappointing as it may be to the people of Britain and their friends oversea, is a wise one. On many occasions the Germans and Italians have issued grossly distorted reports with, it is suspected, the intention of provoking the Admiralty to disclose the true facts; but the Admiralty has refused to be caught in this snare. It has kept complete silence or has nailed the lie to the counter with a curt and contemptuous retort. On no subject has the oyster kept more resolutely closed than on that of the destruction of enemy submarines. At one period we could rely on hearing that two a week were being sunk; but for months past no indication of the toll has been made public. That is, no doubt, particularly galling to the enemy. He has to "presume losses" when his boats are overdue, and is left without knowledge as to when they were lost, where they were lost, and sometimes what damage, if any, they had succeeded in inflicting before they became the victims of depth charges, bombs, guns, mines, or other devices designed for their destruction. Even now, after many months, the public is being kept wholly uninformed about this particular aspect of the war at sea. Its faith in the Navy and the Fleet Air Arm is kept alive by rare records of their successes, but it never doubts that the good work goes on ceaselessly, night and day.

On Wednesday, March 5th, Mr. Alexander, First Lord of the Admiralty, presented the Navy Estimates for the current year, and in doing so took the opportunity to review very broadly the work of the Navy and its auxiliaries in past months, and to hint at the scale of the developments that are taking place. But he added not one item to our knowledge of the progress of the war at sea. He spoke of the enormously increased difficulties that had to be faced after the collapse of French resistance and the surrender of the Channel and Atlantic ports, he mentioned the losses we had sustained, particularly in the lighter classes of ships, and acknowledged the help that the fifty American destroyers were to us in the unceasing battle in the Atlantic. He spoke, too, of the success of the convoy system, and referred proudly to the fact that whole convoys of troopships had been conducted across the oceans and along the Mediterranean by the Navy without the loss of a single unit. All these and many other heartening things he told a responsive House of Commons, but never did he reveal a single new fact about the successes of our ships or their airborne auxiliaries. He kept the veil of secrecy tightly drawn and pinned with safety pins. The public will respect his desire to keep even odd scraps of information from the enemy, but they will miss the stirring of the heart that comes from the account of well-fought fights and regret that, in his wisdom, he has withheld the exhilaration which his predecessor evoked by a triumphant note. It was what one might almost call a business-like speech, such a speech as the chairman of a board of directors might make when he knew that he was going to get what he wanted, and no particular effort to convert wavering shareholders was called for. Needless to say, Mr. Alexander got his "token vote"—a sum was never mentioned—without an iota of dissent.

Taking the German official *communiqués* only, Mr. Alexander said, it would appear that the British Navy had lost twice the number of capital ships, aircraft carriers, and cruisers with which we started the war, and more than all the submarines. In fact, the great body of the Fleet of August, 1939, remained intact. The number of ships in most classes, and especially in the destroyer class, now at sea or instantly ready for sea, was at the moment greater than at any time since the war began. He added that the ships that would come into service this year would of themselves make up a formidable force, judged by almost any other Naval Power's standard. It will be remembered that on February 1st, 1940, the Admiralty took over the control of the building and repair of merchant ships for the duration of the war. When, then, Mr. Alexander told the House that "no fewer than one hundred and fifty-four new factories or extensions of existing works have been completed during the year for Admiralty work, or are in hand," it is probable that he had in mind merchant as well as naval shipbuilding and repair, and he may have included also some of the factories which for the first time in their existence have undertaken the construction of special classes of naval vessels. But however the figure is looked at, it is a remarkable one. It shows in a positive way the preponderant importance of the part that the sea is still playing in this war. Great Britain and all the countries of the Commonwealth are not likely to overlook that fact for a single moment, even when they are most stirred by the great military achievements in North and East Africa, but they will, nevertheless, appreciate and be impressed by such a concrete reminder of the effort that is necessary to retain and make doubly secure the mastery of the seas.

Passing to another subject, Mr. Alexander touched upon the enemy's attack on shipping and the submarine campaign. Noting the inevitable consequence of the French disaster, he told the House that whilst up to May last some forty thousand tons of British, Allied, and neutral shipping had been lost on an average every week, the figure rose during the next seven months to more than double that figure, namely, ninety thousand tons per week. Then came the winter weeks, eleven of them, in which the average loss fell to fifty-one thousand tons per week. He did not claim that this great diminution was entirely due to our improved methods of protection, but he thought that these methods "can be counted as at least among other possibilities." Raiders apart, the losses are attributable to mines, aircraft, and submarines. The first named is being faced, not with complacency but confidence, but since the French ports passed into German hands the menace of the U-boat and the bomber on the Atlantic has greatly increased. Against them counter measures have to be devised, and it was satisfactory to have Mr. Alexander's assurance that they are being developed. The Germans have recently redoubled their threats and have encouraged the circulation of grossly exaggerated figures of the number of submarines they have ready for sea, and Hitler has told the world of his intention to develop the "wolf-pack" method of attack this spring. The U-boats may give us a severe trial, but we say with some confidence that they will be a trial to Germany, too. It is not in the remotest degree likely that men have been properly trained for such specialised work as the handling of submarines in sufficient numbers to man a large flotilla—one hundred and fifty has been estimated as the number—and it is equally certain that the craft themselves, fabricated by mass-production methods in great haste, will fall far below the standard of construction which is, in fact, called for. Hitler, we know, is regardless of human life, but even he may be checked by the losses which U-boats so made and so handled are likely to suffer at the hands of a flotilla and an air force specially detailed for their destruction, and manned by daring, resolute, and ever watchful crews. We may suffer grievously for a time, for a new form of attack calls for new counter measures, but we have confidence in the First Lord's assurance that the German commanders will find it "progressively less easy to exploit the advantage which they gained from the successes of the German Army."

Mr. Alexander concluded his speech with a peroration which provoked frequent and at the end loud and prolonged cheers. In our solemn hour of national testing, he said, the Royal Navy was bearing an immense responsibility, but this was no new thing in our history. As had been demonstrated by the Army in the Middle East and by the Royal Air Force over these islands, so by the day-to-day exploits of the Royal Navy the spirit was the same as ever, and the leadership in no way inferior to that of the past. He wished to pay his tribute to the courage, wisdom, and skill of the First Sea Lord and his staff, to that great sea captain Admiral Sir Andrew Cunningham, to Admiral Sir Charles Forbes, and the Commanders-in-Chief on all stations for the services they had rendered and continued to render. All of them, together with the loyalty and devotion of the men serving under them, would continue to prove that the path of duty was the way of glory, but their greatest glory, and the greatest reward of the whole Fleet, would be when the day of victory was ours and Freedom, now in chains in Europe, might once more hold up her head.

At the very moment when the First Lord was addressing the House of Commons, detailed reports of a daring exploit in Norway were coming in. It was soon made publicly known that without loss of any kind, in man or material, a British naval expedition had landed on the Lofoten Islands, at the mouth of the fjord that leads up to Narvik, had there destroyed utterly plants used for the production of fish oil, had killed a few Germans, captured many others, and had carried off a large number of patriotic Norwegians and a handful of Quislings. At the same time, it was busy amongst German shipping. One fully laden ship of 10,000 tons was sunk with nine other small craft, amounting to 8000 tons in all, and an armed trawler. It is such expéditions as that, carrying on the old traditions of the British Navy and British seamen, that exalt our spirits as much as they must depress those of our enemies. They fill us with abounding confidence that, come good days, come bad days, the Navy of the King will never be found wanting in skill, daring and courage, and that in the end, as so often before, it will lead the way to victory.

Air Force Targets in Germany

No. XVIII

(*Continued from page 128, February 21st*)

BREMERHAVEN AND BREMEN

THE Hansa city of Bremen, situated on the River Weser, with its rich historical associations, has a population of over half a million people, and is the second port in Northern Germany. More than that, it forms a highly important railway and manufacturing centre, with its own rail, road, sea, and air connections, with all parts of Germany, principally the areas lying in the direction of Hanover and Magdeburg.

A great part of the prewar railway and sea traffic was, however, operated from the port of Bremerhaven, a town with a population of close upon 27,000 people, on the right bank of the River Weser, about 32 miles from its mouth. That port is the arrival and departure centre for the fast liners of the Norddeutscher Lloyd Company, which has established its own quay railway station and repair works at Bremerhaven. In one of our engravings we illustrate the 51,000-ton liner "Europa" berthing at the 1000-m. long Columbus Quay. From Bremerhaven passengers usually proceed to the city of Bremen, which is 34 nautical

AIR VIEW OF BREMEN

miles further up the river, and is 67 miles from the Weser mouth. Other illustrations accompanying this article show an air view of the city of Bremen, and a map of the industrial part of the city with the dock area, along with a typical view of the discharging arrangements and sheds in the harbour.

BOMBING ATTACKS

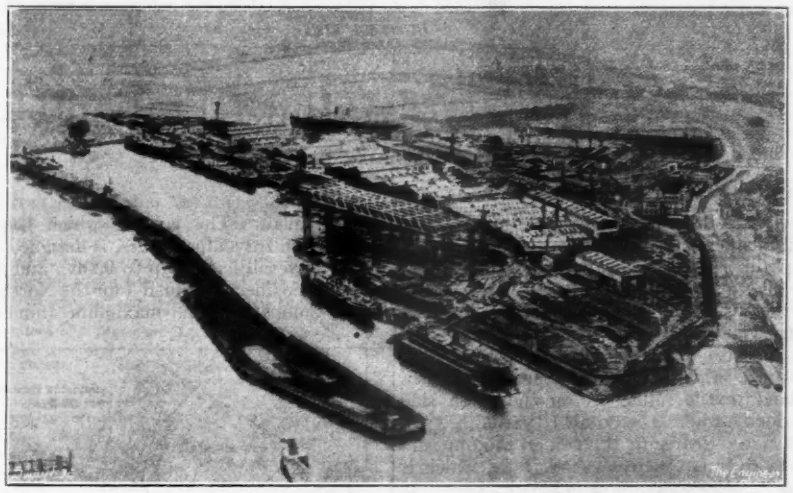
The city of Bremen and its port of Bremerhaven figure often in the returns of the bombing attacks carried out by the aircraft of the Bomber Command. In July and September, 1940, heavy attacks were made on more than one occasion on the jetties, docks, ships, and shipbuilding and repairing yards at Bremerhaven. With regard to Bremen itself, it is shown that up to the end of 1940 no less than fifty-two major attacks were made on the city, principally on its docks, railway stations, and shunting yards, oil works, engineering works and shipbuilding yards, and manufacturing plants. Among these plants were the large modern oil refineries of the Deutsche-Vacuum Oel Gesellschaft, the Focke-Wolf Airframe Factory, the rice and starch mills of Gebrüder Nielson, and the shipyard of the Deutschen Schiff-und Maschinenbau A.G. (Werk A.G. Weser). At the beginning of the present year, from January 1st to 4th, particularly heavy bombing attacks were again made on these targets, and it is officially reported that extensive damage was caused both by fires resulting from incendiary bombs and by high-explosive bombs.

BREMEN'S DOCK SYSTEM

The accompanying drawing, which we reproduce from Admiralty Chart No. 3506 by permission of the Hydrographer of the Admiralty, shows clearly the general lay-out of the principal docks and basins, around which much of the city's industry is grouped. The river is kept free of ice during the winter by icebreakers, and its dredged depth is such that ships drawing 28ft. can proceed to the Bremen docks at normal tides. The rise of tide, it may be stated, is about 10ft. to 11ft., and with the exception of the industry and commerce system all the Bremen docks are tidal in character. The import trade of the city is very varied and consisted before the war mainly of raw materials for its own manufacturing plants and those of other centres served by the Reichsbahn. It comprised mineral oils, cotton, grain, wool and woollen goods, paper and paper-making materials, timber, ores, coffee, oil fruits and seeds, hides and skins, cellulose, tobacco, jute, and copper. Most of these incoming materials were taken by the factories in the immediate district. The goods exported from Bremen and Bremerhaven consisted of iron and steel products, coal, coke, cement, chemicals, mineral salts, potash, machinery, textiles, motor-cars, leather, flour, and other items such as cellulose and toys. From the port of Bremerhaven there were about 73,000 persons arriving per year with nearly double the amount of departures, and some 25,000 packages of luggage were also dealt with.

The total amount of goods handled at Bremen and Bremerhaven and transferred to the railways was between 2 and 3 million tons. Bremen is essentially a railway port, and at some places on the quays there are three or four lines of rails, with two to four behind the sheds and alongside the various factories and warehouses. The efficient quay length of the port of Bremen is 27,000 m. There is a total area of sheds on the quays, amounting to 260,000 square metres, while the amount of storage for goods provided in storage sheds and warehouses, both privately owned and belonging to the port authority, amounts to over half a million square metres. One of our engravings shows the particular type of shed crane employed; there are over 250 of these cranes with lifting capacities of from 1½ to 5 tons. For heavier lifts several 16-ton cranes are available, while there are also in the port two Government floating cranes capable of lifting 12½ and 60 tons, while two further large floating cranes owned by the Deschimag Shipyard are of 25 and 100 tons lifting capacity respectively.

Starting from the part of the city near the Weser station shown at the foot of the drawing herewith the Europa Dock may be noted. This forms part of the Free Harbour and is not in the Customs Union. It has a length of 1850 m. and is from 112 m. to 120 m. wide. The depth of water at low tide is 18ft. There are twelve sheds in this basin, and one of these is reserved for fruit handling. Before the war Bremen was the centre of the German banana distributing trade. There are forty-four electric cranes and fifty-four travelling hydraulic cranes with capacities from 1½ to 4 tons in this dock. The adjoining Overseas Dock is also in the Free Harbour. It has a total length of 1070 m., and a breadth from 100 m. to 130 m., with a depth at low water of 28ft. On the quays of this dock there are nine sheds, which are equipped with 104 travelling cranes, having jibs of variable radius, and designed lifting capacities varying from 2½ to 5 tons. The Grain Dock forms part of the Customs Harbour along with the other docks of the port, but is also the outer basin for the Free Harbour. Its equipment comprises a stationary grain transhipment plant owned by the Bremer Lagerhaus-Gesellschaft, with two piers, each with a length of 170 m. and a width of 15 m. They



AIR VIEW OF DESCHIMAG HARBOUR

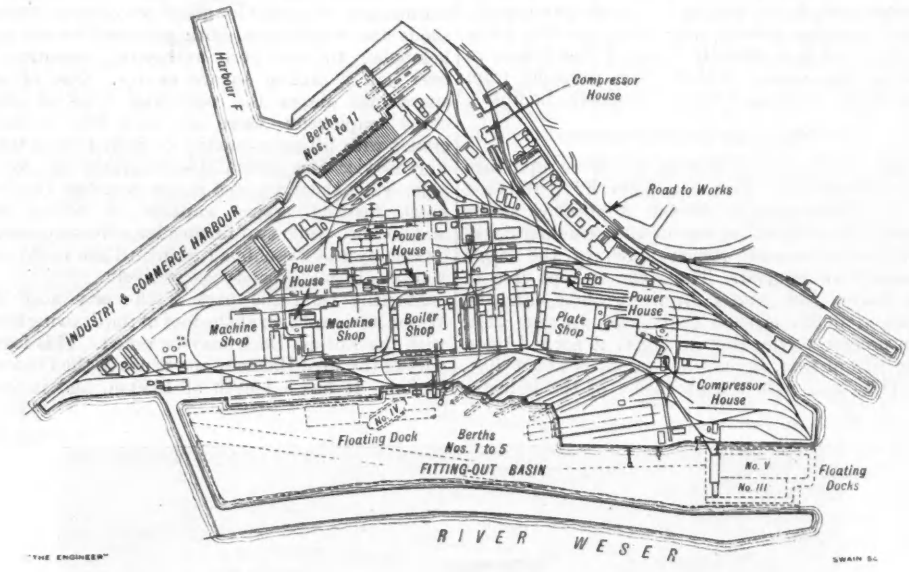
S.S. "EUROPA" ARRIVING AT BREMERHAVEN

TYPICAL VIEW IN BREMEN HARBOUR

are served by two railway tracks, and there are altogether eleven suction pipes and about thirty-five conveyor belts. The capacity of the grain-handling plant is 7400 tons per day, and close to the dock are grain warehouses and silos having a total storage capacity of 78,000 tons. In addition to the fixed plant there is floating grain-handling plant having an output of between 1200 and 2000 tons of grain per day. Facilities for discharging grain ships directly into railway wagons and barges, or to the silos are also provided.

A further Customs dock is that called the Wood and Factory Dock, which has a length of 1450 m., a width of 95 m., and a depth of 20ft. The factories, which include the famous Hansa and Roland textile mills, are on the north side of the dock, while the timber yards are on the south side. Nearer to Bremen on the opposite side of the river is the Hohentors Dock, which is shown on the bottom of our plan drawing. It consists of two basins, one with a length of 700 m. and the other 300 m. in length, with widths of 50 m. and 60 m. respectively. The basins are also equipped with electric cranes. The largest system of docks is that called the Industry and Commerce section, which, as our drawing indicates, consists of six separate basins or docks, connected by a long canal. It is the only harbour not affected by the tide, and is entered by an entrance lock having a width of 82ft. and a depth of 28ft. The different basins vary in length, the shortest being 310 m. and the longest 1770 m. The length of the connecting canal is close upon 2500 m. The oil dock serves the oil refinery of the Deutsche-Vacuum Oel Gesellschaft, one of the best equipped refineries in Germany, and a very large works. The iron dock is reserved for the iron and steel trade, and is quite near to the Norddeutsche Hütte iron and steel concern.

As well as the coal dock there is a floating coal-handling plant owned by the Deutsche Kohlen-handelsgesellschaft, while the special coal trans-shipment trade is carried out by the Bremer Umschlags und Handels G.m.b.H. belonging to the Röchling Konzern. The plant has an output of about 400 tons per hour. In addition to these two plants there are other bunkering plants both for coal and oil fuel at various points in the harbour system. A special plant in the potash dock is designed for the efficient transhipment of cargoes of artificial manures such as potash and manufactured fertilisers. Storage is provided for about 120,000 tons of potash and the handling plant is designed to deal with 5500 tons in a shift of eight hours. For the transhipment of bulk goods and cargoes there are five large travelling cranes and five loading bridges. What appears above shows the importance of this harbour system in Germany's war effort.

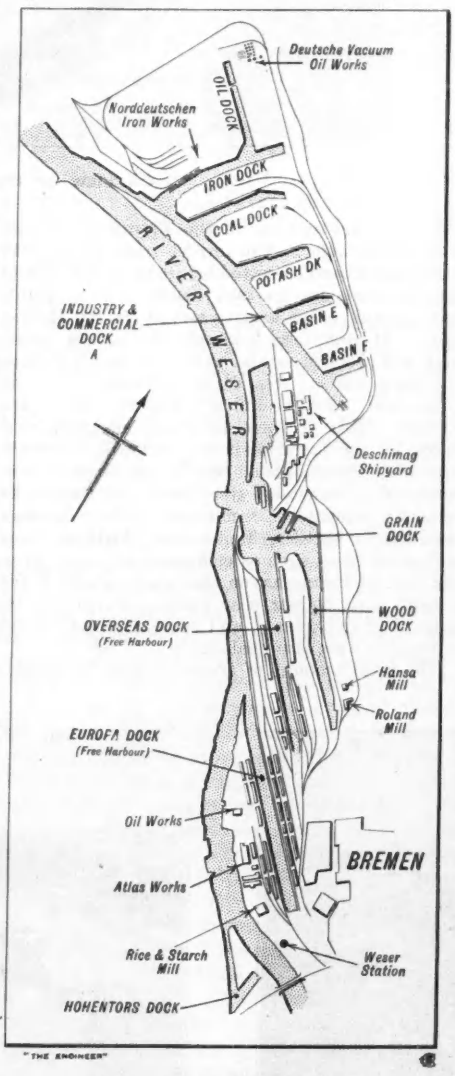


PLAN OF DESCHIMAG SHIPYARD

THE DESCHIMAG SHIPYARD

In nearly all the main attacks on the port of Bremen one of the outstanding targets has been the shipbuilding and ship-repairing yard of the Deutsche Schiff-und Maschinenbau A.G. (Werk A.G. Weser). This firm has also a branch establishment at Wesermünde, and is also owner of the Vulkan-Werk at Hamburg, which was referred to in our article of December 6th, 1940, on the port of Hamburg and its shipbuilding industry. The Deschimag Yard, to use its shorter title, is next to the Hamburg yard of Blohm und Voss, one of the largest and best-equipped shipyards in Northern Germany. It has in all eleven shipbuilding berths, most of which are indicated on the accompanying plan. The largest, which has a steel gantry with travelling cranes, is designed for ships with an overall length up to 950ft., and was used to build the liner "Bremen" for the North German Lloyd Company. The maximum annual output of the shipyard is assessed at 90,000 tons with an engine works capacity of about 150,000 S.H.P.

It will be seen from our drawing that the shipyard and engine works are built on a triangular site fronting the River Weser, and joined on the left-hand side by the Industry and Commerce Harbour Basin A, while around the works and to the right are railway connections and roads leading to the yard. In front of the yard there is a commodious fitting-out basin. We have indicated the main machine shops, boiler shops, and power-houses, and also the compressor houses, which serve the pneumatic machines. Repairs form an important part of the company's activities, and to facilitate such work there are five floating dry docks, with lifting capacities from 1100 to 17,000 tons, and dimensions varying from 135ft. in length, with a breadth of 46ft., to 620ft. long and 98ft. in width in the case of the largest dock. The smaller ships are dealt with on three patent slipways at Wesermünde. The Deschimag Yard is famous for several ships of outstanding merit. We need only recall the "Bremen," completed in 1930, with her measurement of 51,000 gross tons, her length of 938ft. 8in., her beam of 101ft. 8in., and her draught of 34ft. 6in., the 18,000 gross ton "Gneisenau," and her sister ship, the "Scharnhorst," both for the Far East services of the North German Lloyd Company. They were completed in 1935, and were representative of two different types of modern propelling machinery, one with geared turbines with high-pressure Wagner-Bauer water-tube boilers, and the other turbo-electric with A.E.G. turbo-generator plant. In 1938 another interesting liner built at the yard was the "Oslofjord," a motorship of 18,673 gross tons, constructed for the Norske Amerika Line service. She is fitted with M.A.N. oil engines.



PLAN OF BREMEN DOCKS

SOME OTHER FACTORIES

Other factories which are mentioned in the Royal Air Force Bomber Command reports, some of which are shown on our plan, include the Atlas Werke A.G., makers of all kinds of marine auxiliaries for naval and mercantile ships, some of which equipment is to be found on practically every German ship, the rice and starch mills of Gebrüder Nielson, and the airframe factory of the Focke-Wulf Company. There is no doubt, however, that other industrial targets were also damaged and destroyed. In our next article we propose to deal with the harbour system at Bremerhaven, and other Royal Air Force targets in the North of Germany.

Treatment of Sewage at Small Works*

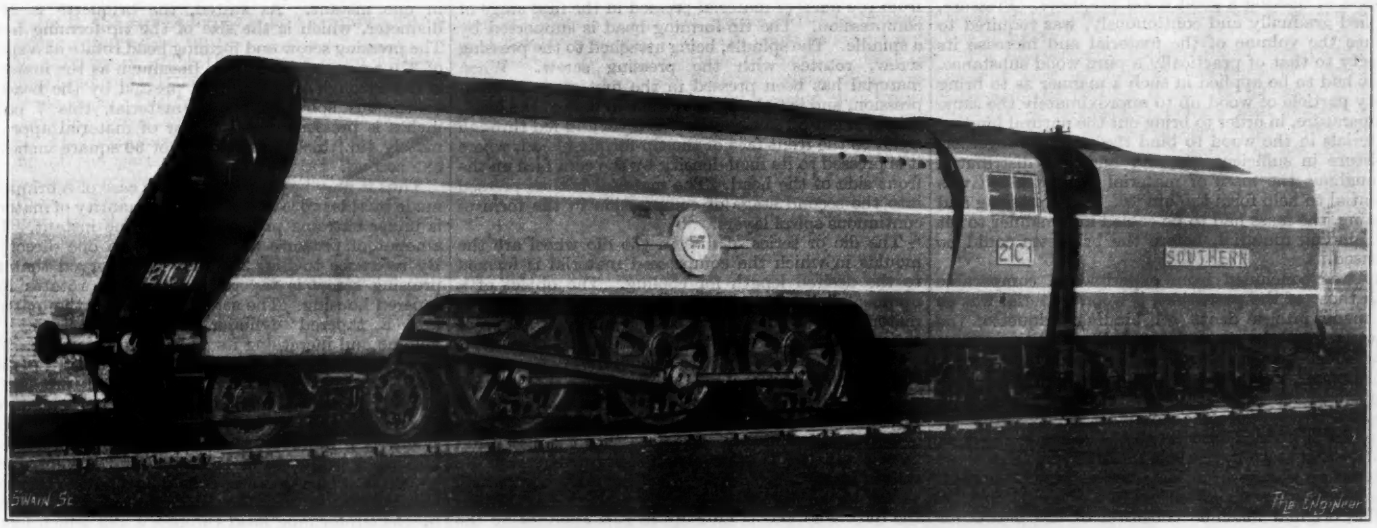
At the Barston Works, near Solihull, the flow in dry weather of 750,000 gallons per day forms the bulk of a stream which rises in the vicinity of the works. The weak sewage received at these works is adequately treated in tanks and bacteria beds provided with rotary distributors, but it has been found that additional purification and removal of solid matter results if the settled bacteria bed effluent is run on to underdrained grass land. At least once each year the grass land is allowed to dry out, and the coarse grass, which is unfit for hay, is cut and burnt. An alternative method of improving the quality of effluent from a small plant at a low cost has been in use at the Board's works at Knowle since September, 1938. Here the sewage from a population of about 2000 is dealt with by settlement in tanks, followed by irrigation of the tank liquor over underdrained grass land, which, because of its excessive gradient, is not especially suited for the purpose. Although the works' effluent was satisfactory according to accepted standards of purity, the dilution afforded to the effluent when discharged into a small brook was insufficient to prevent the formation of undesirable growths during hot weather, and steps were therefore taken in 1938 to improve the quality of the effluent. These consisted of installing a pump of sufficient capacity to dilute the tank effluent with three volumes of grass land effluent, pumped back from the outfall. The volume of effluent discharged is equal to the volume of sewage received, but the volume of liquid in circulation and undergoing land treatment is four times as great. Since the scheme has been in operation the effluent has been much improved, and the objectionable growths in the brook no longer appear in hot weather. A similar arrangement recently installed at the Norton Green Works in the same neighbourhood promises to be equally successful in its results.

"EFFICIENCY MEASUREMENTS ON RECTIFIER EQUIPMENTS."—In the article on "Efficiency Measurements on Rectifier Equipments," published in our issue of February 28th, the switch shown in Fig. 6 for changing the wattmeter scale should have a resistance connected across its contacts.

* From the Annual Report for the year 1939–40 of the Birmingham Tame and Rea District Drainage Board.

SOUTHERN RAILWAY—"MERCHANT NAVY" CLASS PACIFIC ENGINE "CHANNEL PACKET"

MR. O. V. BULLEID, CHIEF MECHANICAL ENGINEER, DESIGNER



Southern Railway—New "Pacific" Engine

MR. O. V. BULLEID has signalised his appointment as C.M.E. of the Southern in the expected manner. He has added a new class and a new type to the steam locomotives of that company. The class is to be known as the "Merchant Navy"—in recognition of the shipping interests of the Southern—and the first engine was named on Monday last by the Minister of Transport, Lieut.-Colonel Moore-Brabazon, "Channel Packet" at a little ceremony at which Mr. Holland-Martin, the chairman of the company, presided.

The engine, of which several views are given herewith, is a very big machine, and a good bit heavier than the "Lord Nelsons." The total estimated weight with tender is 142 tons 10 cwt. in running order. It is not improbable that she may turn a little more on the scales. The three drivers are equally loaded at 21 tons each, the bogie carries 15 tons 10 cwt., and the trailing pair 14 tons. The total wheelbase is 59ft. 6in., and the length over buffers 69ft. 7¼in. The boiler centre line is about 9ft. 5¼in. from rail surface. The tender is not new. It takes 5000 gallons of water and 5 tons of coal. The leading dimensions of the engine are given in the table.

The first things that strike one about the appearance of the engine, apart from its great size, are that it is completely faired, or "air-smoothed," as Mr. Bulleid calls it, by a steel sheet covering which is carried "all fore and aft" entirely on the frame; the other is the use of double-disc patent B.F.B. wheels to which the eye is not yet accustomed. They are of cast steel. Another external feature is a cab which can be totally enclosed by curtains over sides and roof in rough weather. It is a very commodious and well-arranged cab, and Mr. Livesay will be glad to know that it has stuffed seats, on the left for the driver and on the right for the fireman. The casing, it will be observed, is carried forward, forming an air collector; at the top a funnel-shaped passage turned up, so to speak, round the "chaplet" of the chimney

Particulars of "Merchant Navy" Class Engine

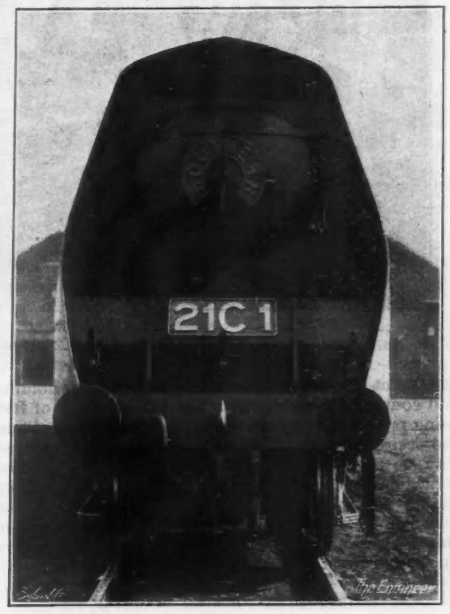
Grate area	48·5 sq. ft.
Fire-box volume	300 cu. ft.
Barrel:	
Maximum diameter	6ft. 3¼in.
Distance between tube plates	17ft.
Cylinders:	
Number	3
Piston diameter, stroke	18in. × 24in.
Valves:	
Diameter and travel	11in., 6¼in.
Tubes:	
Number	124
Diameter	2¼in.
Flues:	
Number	40
Diameter	5¼in.
Evaporative heating surface	2451 sq. ft.
Superheater:	
Heating surface	822 sq. ft.
Total combined heating surface	3273 sq. ft.
Tractive effort	37,500 lb.

provides an updraught to carry away smoke and steam. Between the frames in front of the smoke-box there is a turbo-electric generator, which lights the whole engine, and two mechanical lubricator pumps.

Coming now to the invisible features of the engine, we must note first that the boiler is designed for 280 lb. pressure, and that it has a steel box with two thermic-siphons. The box is, of course, of the wide type. Both the inner and outer boxes are welded. The boiler is lagged with spun glass mattresses. A still more interesting feature, because it is, we believe, quite unprecedented in this country, is the employment of a three-throw dummy shaft, chain-driven, for operating the valves. The valve gear, which Mr. Bulleid has patented, is entirely enclosed in an oil-tight casing inside the frames, the casing also enclosing the central connecting-rod, crosshead, and crank. All bearings within this casing are lubricated by a continuous stream of oil pumped by gear pumps from the sump.

The two outside cylinders are horizontal, the inside one is inclined and set a little further back.

Nine similar engines are under construction, and



HEAD-ON VIEW

will be named after shipping lines using Southampton Docks, and each will bear on its name-plate a replica of the shipping company's house flag.

We hope to be able to describe in due course some of the interesting technical details which Mr. Bulleid has incorporated into a design of which he may justly be very proud.

INTERIOR OF CAB

OIL IN MANCHOUKUO.—It is some months since the first oil well at the Fuhsin field in Jehol Province was sunk. The actual output of this well has not yet been announced, but it is now reported that a considerable amount of oil is being obtained daily and that a second well is being sunk. The presence of oil at Fuhsin was first discovered several years ago when coal-mining operations were being expanded. Geological surveys, started in 1938 by the Manchuria Petroleum Company and two other mining development companies, confirmed the original discovery and found evidences suggesting a large oilfield. Test borings were begun in August, 1939, and oil was finally struck on April 28th at a depth of about 100 m. The extent of the oilfield is not definitely known, but apparently it is potentially important.

A Wood-Briquetting Machine*

EXPERIMENTS clearly indicated that pressure, heat, moisture, and cooling would be necessary in the process of making a good wood briquette. Pressure, applied gradually and continuously, was required to reduce the volume of the material and increase its density to that of practically a pure wood substance. Heat had to be applied in such a manner as to bring every particle of wood up to approximately the same temperature, in order to bring out the natural binding materials in the wood to bind the particles together. Moisture in sufficient quantity and well distributed throughout the mass of material being pressed was essential to help form the binder. After pressing and heating, the mass had to be cooled in a manner to set the binding material, before the briquette could be released.

It was concluded from experiments, comparable with those of the past, that, if wood material was to be made into a dense self-binding briquette, the material must be pressed in small quantities at one time under great pressure ; that the pressure must be continuous and gradual from the time pressure is first applied to the loose material, continuing until it is pressed into its final state ; and further, that after the material is pressed into its final density it must be held in this state until cooled. After reaching these conclusions the problem then was to design a complete machine to carry out the process.

The original machine consisted of the means for pressing material gradually and continuously in the form of a tapered pressing screw, a die, or series of dies, in which to form and cool the briquettes, and a yielding pressure control which governed the density of the briquettes. Briquettes could be made with this machine, but not consistently or to the desired density at all times. The theory of pressing, holding and controlling was correct, but the quantity of fuel being pressed at a given time was too great to obtain the desired density. The problem then was, in some way, to press the material yet more by this gradual continuous method. A means to this end was worked out in the form of a tip forming head which was attached to the pressing screw. The development of this device was the final solution in the practical production of wood briquettes.

BRIQUETTE-FORMING MACHINE

The wood briquette machine, as finally developed, consisted of such essential parts as the pressing screw, the tip-forming head, the pressing screw shaft bearing housing, the pressing screw and tip-forming head housing, the dies, die wheel and die wheel indexing mechanism, and the yielding pressure control mechanism.

Reference to Fig. 2 will identify each of these essential parts, and their functions are herewith described. The pressing screw performs two functions, that of receiving material from the source of supply and of pressing this material through the first stage of compression. Note that the screw is tapered ; therefore, as the material is moved forward it is pressed into a constantly decreasing space. The space directly ahead of the screw and up to the rear side of the tip-forming head is the first stage of compression. It is the function of the pressing screw to keep this space full of tightly compressed material.

The function of the tip-forming head is to take material from the first stage of compression, feed and press it into the second stage of compression. The tip-forming head is designed with a cam face on both its front and rear faces. At the high point of the lead on the rear face a slot is cut diagonally through the head ; this slot enters the front face of the head at the low point of the lead. Since the high point of the lead on the rear face of the head forms the start of one side of the slot through the head, it is therefore a cutting edge, by which the material may be sliced from the mass of material pressed in the first stage of compression. The tip-forming head is supported by a spindle. The spindle, being attached to the pressing screw, rotates with the pressing screw. When material has been pressed in the first stage of compression, and is tight against the rear side of the head, it is then cut off in a continuous layer and fed through a slot to the front face of the tip-forming head, where it is pressed to its final density by the cam face on the front side of the head. The material is thus pressed into the second stage of compression in the form of continuous spiral layers.

The die or series of dies in the die wheel are the moulds in which the compressed material is formed to the desired length for cooling. The object of a number of dies is to provide a means of holding the material in the compressed state a sufficient length of time to cool, and to obtain, as nearly as possible, a continuous operation of the machine.

The yielding control pressure performs the function of controlling the density of the briquette as it is formed. This yielding pressure is obtained by means of a hydraulic cylinder. Pressure from the piston-rod of this cylinder is transmitted against the briquette as it is formed through the medium of the completely cooled briquette, which is ready to be removed from the die. Pressure is built up in this cylinder by the formation of a new briquette, the cooled briquette being pushed out of the die against the cylinder rod and piston in the cylinder. The cylinder back of the piston is always full of oil, therefore any movement of the piston toward the end of the cylinder will build up a pressure if all outlets from the cylinder are closed. This is the case except that pressure is built up against an automatic relief valve. This valve may be set at any pressure which will ensure the desired density of briquette. Since the formation of a briquette is at a constant rate at a given pressure, the counter pressure built up in the yielding pressure control cylinder will vary with the speed of formation of a briquette.

In the formation of a briquette the yielding pressure continues during the formation until the desired or standard length is obtained. When this length is obtained the pressing screw stops automatically. At the same time, the index mechanism starts operating and indexes the die wheel one position. At a position about one half the movement of the index arm the mechanism on the yielding pressure control is energised, which releases pressure in the cylinder. By means of a suitable mechanism the piston-rod of this cylinder pulls away from the end of the cooled briquette which has just been removed from the die and allows it to drop by gravity out of alignment with the rod and die. At the end of this stroke, which is just sufficient to allow the briquette to fall out of line, the mechanism is automatically reversed, permitting the piston-rod to be moved forward until it is in contact with the face of the die disc, which is also at the end of the next cooled briquette to be removed from the die. At this point of contact of rod and briquette the pressing screw is started automatically, thus beginning the formation of another briquette. This cycle is completed over and over in the process of making briquettes.

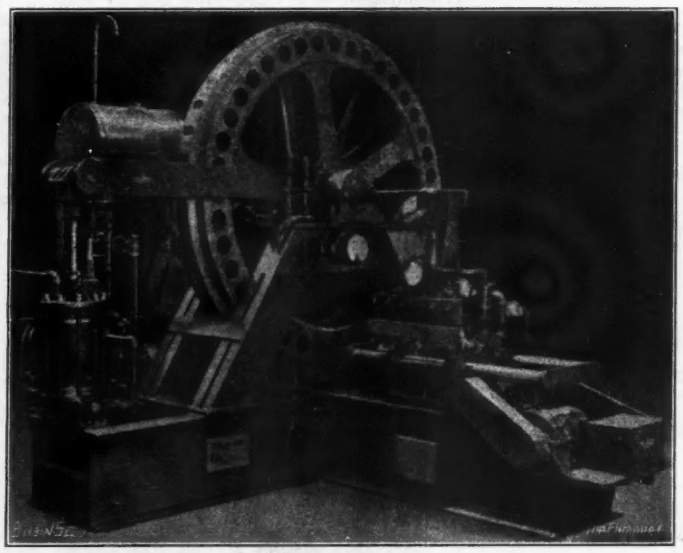
STANDARD BRIQUETTES PRODUCED

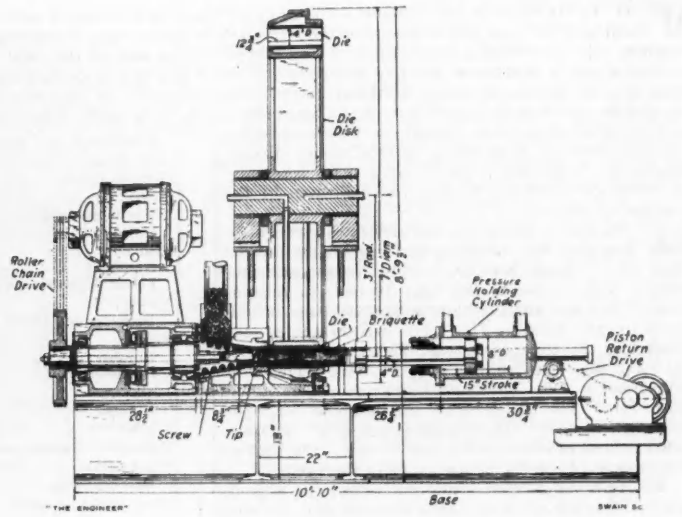
The standard briquette, as made with this machine, is 4⅛in. diameter and 12¾in. long ; its weight is 8 lb.; the density is 1·3 for the average briquette. For special purposes, if desired, the material may be pressed to a density of 1·4, which is approximately that of bakelite.

In the formation of a briquette the material is pressed at the rate of 7 cubic inches per second. However, this does not mean that 7 cubic inches is pressed in one instant. As stated, the briquette is 4⅛in. diameter, which is the size of the tip-forming head. The pressing screw and forming head rotate at a speed of 270 r.p.m. or 4·5 r.p.s. Inasmuch as the material is fed through the head and pressed by the head in continuous spiral layers of material, this 7 cubic inches is pressed in a tin layer of material approximately ¼in. thick over an area of 60 square inches in one second.

Thus it may be seen that, in the case of a briquette made by this process, only a small quantity of material is under extreme pressure at any one instant. The amount of pressure used is not all in one direction. By reference to Fig. 2 it may be observed that the pressing screw is tapered and that it rotates in a tapered housing. The screw compresses the material into a tapered cylinder, thereby decreasing its volume and increasing its density very rapidly. This action results in heavy thrust loads against the screw and its supporting shaft. This total pressure is normally about 165,000 lb. The counter pressure of the yielding control pressure cylinder varies considerably ; however, the minimum total pressure in making a briquette is 15,000 lb. and the maximum 25,000 lb. This pressure is held against the briquette as it is formed ; therefore, since the material is formed by the tip-forming head through a slot which has an area of only 1 square inch, the counter pressure on the material, as it is formed, is from 15,000 lb. to 25,000 lb. per square inch.

Briquettes made by this process are entirely self-binding. Just what the binding material consists of has not yet been determined. It is a known fact that the binding material is not pitch, as those wood materials containing little or no pitch make the best briquettes.





FIGS. 1 AND 2—APPEARANCE AND SECTIONAL ARRANGEMENT OF WOOD-BRIQUETTING MACHINE

RECENT IMPROVEMENTS IN BRIQUETTING MACHINE

From the time of inception of the tip-forming head and up to the early part of 1939 the tip head formed a flat smooth-surfaced layer in the briquetting process. While a briquette made up of these smooth-surfaced layers was extremely dense, it would break in two or more pieces with rough handling and, at times, the layer on the end of the briquettes would break off. To eliminate this fault of the briquettes an improvement was incorporated in the tip-forming head, in the form of three concentric ribs on the front cam face. As previously stated, the front face of the head presses the material into its final density ; therefore any desired change in the shape of the layer would have to be made by a change in this face of the head. The three concentric raised ribs of this face make indentations or corrugations in each layer of material conforming with the shape of the pressing head, thereby interlocking the layers as they are formed. This interlocking of the layers makes a stronger briquette mechanically, and increases production but does not increase the density of the original briquette.

The tip-forming head is removable from the pressing screw, since it receives more wear than any other part of the machine. A tip head will ordinarily make 400 to 600 tons of briquettes without repairs. Usually several repairs are made before the tip is useless. It is not unusual for a tip-forming head to make a total of 750,000 briquettes.

Further improvement of the tip-forming head has been made. It is desirable to increase the production of the briquette machine to the largest possible output in order to make briquettes at the lowest possible cost. The latest development to increase

* From a paper by R. T. Bowling, Chief Engineer, Wood Briquettes, Inc., Lewiston, Idaho. A.S.M.E., 1940.

production is the double-headed tip-forming head. This head provides means for a three-stage compression instead of two stages as has been described. The theory of the three-stage compression unit is that more heat and more pressure may be applied to a given quantity of material in the same time. Therefore more material may be pressed into a briquette in the same time as is now required with a two-stage compression unit.

The cylinder in which the pressing screw and tip-forming head rotate is designated as the screw housing and cone liner. The cone liner is the part in which the pressing screw and tip-forming head actually work. This liner is removable from the housing, as it is one of the parts of the machine which require replacement in relation to the quantity of briquettes produced. This liner is hard-surfaced in the same manner as the pressing screw and tip-forming head.

The dies in which briquettes are pressed for cooling are made of 18–8 stainless steel. Experience indicated that these dies must be of a non-corrosive material and one with a low coefficient of friction. The inside dimensions of the dies is controlled by the species of wood material being briquetted. With some species the bore of the die may be straight. In others the bore may be tapered as much as 0·040in. in the die length.

The die wheel in which the dies are retained is a steel casting, supported by a central shaft. Space is provided around the dies for the circulation of cooling water. On the outer rim of the die wheel several notches are cut for indexing the wheel from die to die when briquettes are being made.

The index mechanism is the means provided for turning the die wheel, consisting of a hydraulic cylinder with its piston and rod. The piston-rod is attached to the wheel through a set of arms and a ratchet pawl. Pressure for the cylinder is provided by a motor-driven gear oil pump. The pump is operated only when required to index the wheel. The pump develops a maximum of 500 lb. per square inch with a capacity of 50 gallons per minute. This volume and pressure index the wheel from one die to the next in four to five seconds. A number of mechanical devices were experimented with for this indexing, but none was as effective or as satisfactory as the hydraulic system.

The yielding pressure control mechanism, while an important feature of the machine, involved no particular problems of design, as did the pressing screw or tip-forming head. This yielding pressure control mechanism is nothing more than a hydraulic cylinder with its piston-rod attached to a crosshead to which is connected two guide rods for mechanical actuation. Therefore the rod may be actuated either by hydraulic means or by mechanical means. The hydraulic method is for the purpose of holding a given pressure against a briquette while it is being formed. The mechanical means is for the purpose of releasing the cooled briquette which has been removed from the die by formation of a new briquette and to return the piston-rod to the starting position.

The controls of the machine are electrical. Two sets of controls are provided, one for automatic operation, the other for manual controls. These controls consist of the latest and best types obtainable. The controls operate 2500 to 3000 times per day.

The total connected load on the machine is 65¾ H.P., 50 H.P. of this being required to drive the pressing screw and tip-forming head, 15 H.P. to drive the index oil pump, and ¾ H.P. on the yielding pressure control cylinder. A total of 65 kWh is required to make 1 ton of briquettes. Capacity of machine is 12 tons of briquettes per day of twenty-four hours.

PLANTS FOR MAKING BRIQUETTES

A briquette machine plant requires other equipment than the briquette machine only. Usually buildings or space in an existing woodworking plant are available to install a briquette machine, but auxiliary equipment, such as conveyors, grinders and fuel bins, must be provided. The cost of making briquettes varies with the cost of labour, power, number of machines being operated and other factors in any given locality.

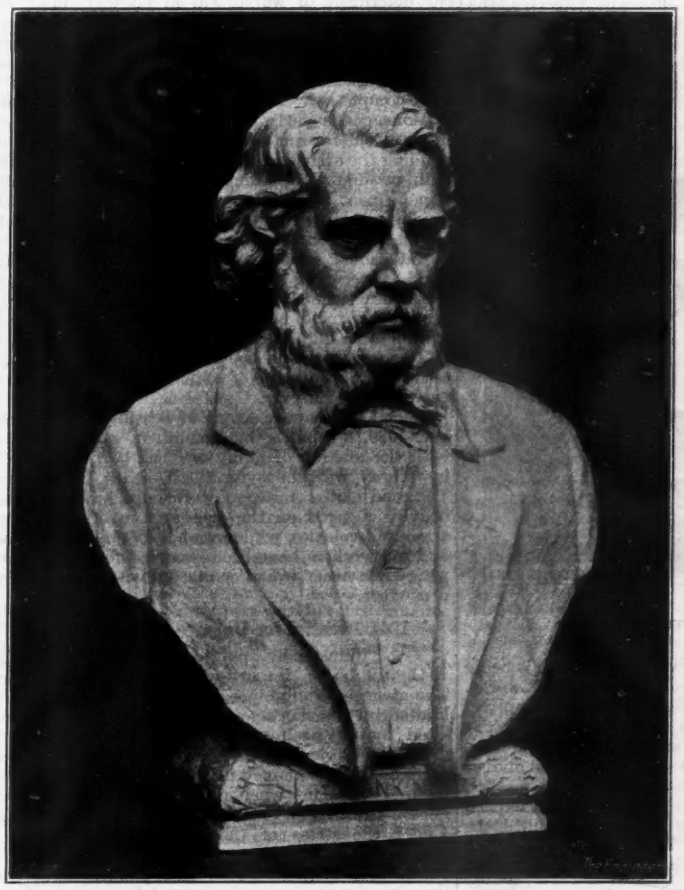
Briquettes have been made of practically all common species of wood and some that are not common. All of them make good briquettes with the proper adjustment of pressing screws and tips. Briquettes have also been made from a great variety of fibrous and non-fibrous materials other than wood, such as wheat and pea straw, alfalfa, sugar beet pulp, almond shells, peach pits, common salt and many others.

To date there are thirty-five machines installed in Idaho, Washington, Oregon, California and Nevada and one in South Africa. These machines have an annual production capacity of 140,000 tons.

Up to the present only one size of briquette has been placed on the market. This particular size, in the form of a small log, was used because it was easy to handle and most economical from the viewpoint of production. Experiments are now being carried out to make small briquettes suitable for firing domestic and commercial stokers. The success of these experiments would broaden the field of usefulness of wood briquetting machines.

W. J. M. Rankine

"TO-DAY," says the Editor of *Mechanical Engineering* (December, 1940), "when we turn our anxious eyes to England whence comes the heritage of our speech and literature, the basis of our civil liberties and common law, and the origins of the technology and industrial society that have made us strong and prosperous, it is appropriate to recall a debt to William John Macquorn Rankine, whose mind conceived and whose genius helped to build that bridge between science and engineering which research and engineering education afford. Professor at the University of Glasgow where Watt tinkered with the model of the Newcomen engine and laid the foundations of an era dependent upon heat power; writer of text-books that are classics of engineering literature; seer, whose keen insight into Nature's mysteries descried the harmonies fundamental to molecular physics, to elasticity, to thermo-dynamics, and to hydro-mechanics; practitioner, who brought to civil engineers, steam engine designers, and shipbuilders rational methods to replace their heroic empiricism; first President of the Institution of Shipbuilders of Scotland; poet, musician, and humorist, who kindled the warmth of conviviality amid the austerities of engineers and university dons—Rankine won his numerous achievements in the face of the handicap of poor health. He was one of the great figures of a golden age.



BUST OF W. J. M. RANKINE

"To one who has worked for years under an almost life-size portrait of this great man, it was a happy circumstance to meet the Anglo-American sculptor, Mr. Bryant Baker, and to accept from him a photograph of his bust of Rankine, unveiled last June at the Virginia Polytechnic Institute as the gift of the Class of 1902 of that institution."

A tablet on the pedestal of the bust carries the following sentences:—

WILLIAM
JOHN MACQUORN
RANKINE
1820–1872

MASTER OF SCIENTIFIC ENGINEERING AND CHIEF AMONG ITS FOUNDERS. HIS MOMENTOUS CONTRIBUTIONS TO THE PROFESSION THAT HE SO HIGHLY ADORNED AND ADVANCED MAKE HIM ONE OF THE WORLD'S GREAT BENEFACTORS.

TO COMMEMORATE THE NOTABLE ACHIEVEMENTS AND EXALTED CHARACTER OF THIS GREAT SCHOLAR, WRITER AND ENGINEER. THIS BUST IS PLACED HERE BY
THE CLASS OF 1902.

Underground Gasification of Coal in the U.S.S.R.

THE following notes, received from a Soviet source, are based on information supplied by the Assistant Head of the Central Administration of the Soviet Gas Industry.

The underground gasification of coal reduces the present cost of fuel to one-third or one-fourth, although the process is still in its infancy and a number of technical problems still remain to be solved. Even at the present stage, however, ten times more workers are required in the coal mines to produce a given quantity of energy in the form of coal than are needed in a gasification station to produce the same amount of energy in the form of gas.

The underground gasification of coal is not a new idea. It was advanced half a century ago by the Russian scientist, D. I. Mendeleyev. "There will probably come a time," he wrote, "when even coal will not be extracted from the earth, but deep down in the earth the coal will be transformed into combustible gas and sent through pipes over long distances for distribution." Work on the underground gasification of coal was begun in the Soviet Union in 1933, when five experimental shafts were sunk in various coal basins of the country. The method employed is as follows: Two inclined shafts are driven down to the coal seams which are to be converted to gas. Under the surface they are connected with each other by a horizontal drift. An air blast is forced underground from the surface along one of the inclined shafts, this blast having an ordinary or increased oxygen content and sometimes containing steam. The blast coming in contact with the white hot coal in the horizontal drift produces combustible gas which is forced to the surface through the second shaft.

In 1937 the first experimental station for the underground gasification of coal on an industrial scale began operation in the Donets coal fields. Millions of cubic metres of combustible gas have been piped off, part of it going directly to a neighbouring factory. This first station has supplied the solution to a number of technical problems, and it has also proved to be a valuable school where experience under actual working conditions has been gained, and where personnel has been trained for new stations under construction. In November of last year a station on an industrial scale started operation in the Moscow coal fields. Another large new gasification station will shortly begin working in the Donets coal basin. This latter station will supply gas to some adjacent chemical works which now consume tens of thousands of tons of liquid fuel annually. In addition, construction will be begun this year of a second section of this station, to produce gas for chemical purposes. This station in the Donets basin is expected to save the labour of some 800 workers, including 500 coal miners. Another large station for the underground gasification of coal is now being built in the same coal fields—Donets basin. This station will form a component part of a large power and chemical works. Including an electric power plant, the works will combine in one system the underground gasification of coal and the generation of electric energy. This station is expected to save the Soviet Union the labour of 2000 workers, of whom 1500 would be underground workers.

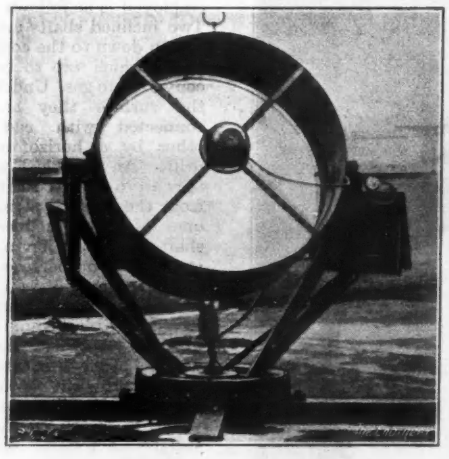
At present about 15 per cent. of the workers in gasification stations are still employed underground, preparing the coal seams and tunnelling drifts to connect the shafts. A second section of the experimental and industrial station opened in the Donets basin in 1937 will start working shortly. At this station for the first time gasification will be effected without shafts, so that not a single worker will be employed underground. A number of bore-holes are drilled down to the coal seam, and they are connected underground; all this work is conducted

from the surface. Gasification by the new shaftless method not only eliminates underground work, but also reduces capital investments by from 15 to 20 per cent. The new shaftless method is being adopted in all new constructions of this type.

In order to ensure a more intense rate of combustion of the coal, and a gas of higher calorific value, an oxygen blast is required. In the combustion of low calorific coal a particularly large quantity of oxygen must be used. The cost of the oxygen, therefore, in no small measure determines the economics of the entire process of underground gasification. The method of liquefying air, worked out by Professor P. L. Kapitsa, has come to the assistance of the new industry. By employing Professor Kapitsa's liquid oxygen machine—industrial models of which have been manufactured—the technical and economic aspects of the new coal gasification industry will be improved considerably.

A Sound-Spotting Scheme

Roof-spotting under conditions of poor visibility is mainly a job of roof-listening. Unless, however, the listening is made really effective, the "take cover" signal may be given on hearing the sound of gunfire and approaching aircraft, when, in fact, there is no danger imminent. Thus valuable working time may be needlessly lost. We illustrate herewith a sound detector, the construction of which



Sound Detector

is within the scope of any private firm, which is being used by Benjamin Electric, Ltd., at its works. The component parts of the detector consist simply of a parabolic reflector, at the focal point of which is fitted a sensitive microphone. Connected to the microphone is a four-valve amplifier, with one or more pairs of earphones as required. The method of using the detector requires no great skill or experience. The operator swivels the reflector until the sound of the aeroplane is coming through at its greatest volume. Then by listening carefully he can

Operating Sound Detector

tell whether the machine is travelling away (when the sound decreases) or towards him (when the volume naturally increases). In the latter case, the "take cover" signal is sounded immediately. In the comparatively short time that this apparatus has been in use, the spotters at the Benjamin works have become highly adept at tracking aircraft, and have eliminated a number of unnecessary "take cover" signals. Our illustrations should help those who may wish to construct a similar outfit. A Rothermel piezo crystal microphone is suspended on rubber at the focal point of the 3ft. parabolic reflector. The four-valve amplifier is matched with both the microphone and the headphones, these latter being of the low-resistance type to withstand rough usage. The cost of the apparatus is not excessive, having regard to the valuable time it will save.

South African Engineering Notes

(By our South African Correspondent)

Cape Town, January 28th

Union Railways New Works Programme

Owing to the prevailing state of emergency, it has been found expedient to modify to some extent the programme of new railway works authorised by the Union Parliament for the current financial year, a measure which will reduce the demand for loan funds to finance capital expenditure, and will at the same time enable the administration to devote its maximum energy towards furthering the national cause.

In giving effect to this decision, due regard has been paid to the present position of the various projects, and every care has been taken to ensure that the deferment of works will in no way affect the efficient operation of railway and harbour services. A number of works contemplated, but not commenced, have been suspended, while others are being retarded to an extent which will delay the date of their completion. Items such as the provision of new stations, goods sheds, and other buildings, in replacement of older structures, are being held in abeyance pending the arrival of more opportune times, and this will, no doubt, occasion a certain amount of disappointment to those members of the staff and the public who had anticipated these improvements. Works of national importance, such as the provision of additional harbour facilities, are, on the other hand, proceeding normally, and will, in fact, be speeded up where possible. Despite the curtailment, the programme of new works contemplated remains a considerable one, and the projects now in hand, or to be commenced in the near future, will entail an estimated expenditure of some £9,045,000 during the current financial year.

Since the commencement of hostilities in September, 1939, a considerable amount of work connected with the making of munitions has been carried out in railway workshops for the Defence Department. The road motor transport workshops have also been heavily engaged on the construction of lorries and armoured vehicles, while numbers of skilled workmen and rail workers have been occupied for considerable periods on other works connected with the country's war effort.

1941 Eventful for Union

Industrially, politically, and economically, 1941 will be an important year for South Africa. The stage is set for increasing industrial expansion, limited by the shortage of skilled labour, but stimulated by the training of thousands of women as industrial workers; sustained prosperity due to the large amount of money in circulation; and the first wartime elections when new provincial councils are chosen towards the end of 1941 and early in 1942. Under the stress of war, the industrialisation of South Africa will be accelerated still further this year, not in a haphazard way, but planned on rational lines by the State, the Industrial Development Corporation, and the Industrial and Agricultural Requirements Commission. A feature of this development will be the organisation of women power to supplement the Union's slender resources in skilled manpower. Hundreds, if not thousands, of women are already working in industries, and more will be absorbed next year to enable the State to maintain and equip the Union's Defence Forces, which are largely dependent on home production. January will see the promulgation of the New Security Regulations which will give the State power to eradicate all subversive elements, whether they are secret associations, organisations, dynamitards, or rumour mongers.

The £5,000,000 Industrial Development Corporation, which is destined to be the guiding hand of the Union's industrial growth, should throw off its first-fruits in this year. In addition to secondary industries, it will probably help to promote key and heavy industries. The Industrial and Agricultural Requirements Commission, which produced its first report in 1940, is still at work in the form of committees designed to give effect to the Commission's recommendations. The Committees will tend to stimulate industry still further, chiefly in the direction of manufacturing essential war requirements which can no longer be obtained from overseas.

Meanwhile, "Iscor" works, the biggest iron and steel producer in the Union, and situated at Pretoria, has expanded its output considerably, and plans have been approved, which will about double its capacity. Much of the machinery for it will be built in South Africa.

The year 1941 will also see the raising of large Government loans to finance the country's war effort. Recent Government loan issues were oversubscribed, and Government will have little difficulty in raising whatever sums it requires. Government spending in 1941 will be up to the same level as in 1940, if not higher, with the result that the public will have more money to invest in war and other loans. Most of the Government expenditure will be in the Union.

Crystalline Gold

A sample of crystalline gold, which was recently found at the Old West mine at Umtali, Southern Rhodesia, has been sent to the British Museum. Crystalline gold is very rare in any part of the world, and was practically unknown in Africa until the specimens were found at the Old West mine. The Old West specimens are probably unique, in that pyramids on the surface of the gold are surmounted by nodules of native silver, whose presence is not recorded in available text-books.

The gold was found at a vertical depth of 490ft. In a drive along a fault plane, particularly at its junction with another fault which joins it at a small angle, a series of projections carrying quartz calcite had previously been noticed. During operations a piece of hanging wall was brought down, opening up a cavity where the "boss boy" saw shining leaves of gold. The Old West mine is a low-grade mine, where visible gold is an unexpected occurrence. There were three sheets of gold about ¼in. apart, sandwiched between glistening crystals of calcite. They were ornamented with triangular markings with raised black spots. The surfaces of the sheets were broken by small projecting pyramids rising in steps or terraces with sloping edges. Most of the pyramids were surrounded by nodules of native silver. The silver was tarnished to a dark lead grey colour, and formed spheroids which were sometimes elongated into short rods. After two specimens had been taken, the remainder was smelted, giving 32 oz. of bullion, 798·7 fine.

Union's Secondary Industries

There has been no material change in secondary industries during the month, but under the stimulus of Government orders and other wartime requirements manufacturing activity is developing steadily, and many factories are working to capacity. Local footwear factories, which have been very busy during recent months on military contracts, had just reported that the demand had eased off, when to their great satisfaction they were called upon to tender for fresh contracts, to the extent of several hundred thousand pairs of military footwear for Northern Africa and the Middle East Imperial requirements. Manufacturers anticipate if these are placed, in addition to renewed buying for the South African Army, factories will again go into full-pressure production.

So far, South Africa has not been adversely affected by the war; on the contrary, the country is experiencing a boom. For 1939 the gold production was just under £100,000,000; for the year just ended, 1940, the value of the gold produced has been £117,917,024. The increase is the largest in the history of the country, but is partially caused by the price of gold per ounce being greater in 1940 than for the greater part of 1939. For the most part of the year the valuation of gold was at 148s. an ounce, and though in the early days of September the price of gold in sterling (and Union) currency was set at 168s., producers were limited to 150s., the Government taking the difference between that figure and 168s.

Exploiting Union's Base Metals

Measures designed to stimulate the exploitation of base metals and to give impoverished diamond diggers a "new deal" will be introduced by Colonel C. F. Stallard, Minister of Mines, during the session of Parliament opening January 27th. In an interview, Colonel Stallard forecast the appointment of a Mining Leases Board for base metals, and the placing of base metals on the same basis as precious metals. Private interests, he said, could not be allowed to hamper the development of frozen potential wealth. He emphasised that there would be no confiscation, and that the private owner of land or mineral rights would have the right of either exploiting a deposit himself or sharing in the proceeds. He intended to introduce a Base Minerals Bill which would give the Department of Mines power to prospect on private as well as Crown land; a Precious Stones Bill to control the issue of diggers' certificates, so that diggers could have a fair prospect of making a living; and a Trading Stores Bill, which would remove certain difficulties.

The Mines Department, Colonel Stallard stated, had been urged to give attention to the finding and exploitation of base metals, and he proposes to introduce legislation which is designed roughly to secure to the country the exploitation of base metals in the same way as the exploitation of precious metals is assured, and assure that private interests are not allowed to stand in the way. Colonel Stallard is an optimist, and thinks that in the far future it is by no means improbable that the Union's base metal production will be of more consequence even than its gold.

The following are the principal base metals and minerals which South Africa desires to exploit, and to a certain extent is actually exploiting, viz., copper chrome ore, iron ore, manganese ore, nickel, tin,

asbestos, corundum, kaolin, and fluorspar. There are others of minor importance, such as beryl, wolfram, and tantalite, which may come into the picture later on. The value of the base mineral production at present is round £2,000,000, and it will be much higher for the current year, as both quantities and prices are improving. For instance, the stimulating effect of the war on the manganese and chrome ore industries is reflected in a rise from 483,289 tons to 685,858 tons in the quantities of those ores railed to the coast for export during the year ended March 31st, 1940, and the current year (ending March 31st, 1941) will certainly show a further considerable increase, and there are certain to be much larger quantities exported of copper and manganese. With regard to nickel, there are two well-known deposits, one near Rustenburg and the other at Insizeva. Plans for the further development of the former are now under consideration. It is difficult to speak with any degree of confidence about the tin position, and all one is entitled to say is that production is not likely to become less. Asbestos production is improving. Corundum, too, is gradually coming into its own. However, when the new measures for stimulating the production of base metals and for prospecting thoroughly the many areas where most of the metals mentioned above are known by prospectors to exist, it is safe to assume that a number of rich fields will be opened up, and here the Metallurgical Research Laboratory established at the University of the Witwatersrand will be able to give invaluable assistance.

Sixty Years Ago

THE AMERICAN CLEOPATRA'S NEEDLE

THE story of the obelisk, familiarly although quite erroneously, known as Cleopatra's Needle, which now stands on the north bank of the Thames near Waterloo Bridge, is already known to our readers. It is perhaps less well known that a companion obelisk originally erected at Heliopolis about 3500 years ago and re-erected at Alexandria in the year 22 B.C., was presented to the United States by Ismail Pasha, Khedive of Egypt, in 1878. Unlike our British needle, which was lying prostrate in the sand, the American obelisk was standing erect on its pedestal. It had therefore to be lowered to the horizontal position before the task of shipping it across the Atlantic could be begun. Following the series of misfortunes which attended his removal of the British obelisk to London, Mr. John Dixon declined the responsibility of removing the companion obelisk to America. That task was, however, successfully accomplished by Lieut.-Commander H. H. Gorringe, U.S.N., and the monument now stands, thanks to his skill and ingenuity, in Central Park, New York. The story of its removal was told in outline in our issue of March 18th, 1881. The obelisk without its pedestal weighed about 196 tons, and measured 69ft. in length. The exact procedure followed in lowering the obelisk and getting it into position in the steamer "Dessoug" was not fully detailed in our article, but we gather that it was similar to the procedure followed in removing it from the steamer and re-erecting it in New York. The "Dessoug" left Alexandria with her cargo on June 12th, 1880, and after some delay caused by a broken crankshaft, but without further mishap, arrived at New York on July 20th. The steamer was hauled out of the water on to the Marine railway at Clifton, Staten Island. Her bows were then opened and the obelisk was drawn out on to a platform. Pontoons were moved beneath it and when the tide was right the obelisk was floated off the platform and brought to a pier at the foot of West Ninety-sixth Street. From the pontoons the obelisk was run on to the pier and across the tracks of the Hudson River Railroad by means of two lots of 6in. channel irons, one set forming a trough within which 5¼in. cannon balls were placed and the other inverted riding above and carrying the obelisk. The rest of the journey was effected by means of rollers running on heavy baulks of timber. The erection of the monument on its pedestal was accomplished by raising it in the horizontal position by means of jacks to such a height that triangular frames could be erected alongside it of sufficient height to enable pivots fixed to the obelisk at its centre of gravity to engage with journals at the heads of the frames. The obelisk was then swung round on the pivots into the vertical position and lowered on to the pedestal.

CANADA'S NEW MINING RECORD.—Canadian mining activity reached a new high-level record last year, according to the "Bulletin" of the Royal Bank of Canada. In its February "Bulletin," preliminary estimates place the output as £110,000,000, compared with £95,000,000 in 1939. The major portion of the increase, particularly in Ontario and Quebec, is attributable to the gold producers and to enhanced production of base metals due to the war. The nickel-copper industry had the most active year in its history. More nickel was sold than in any previous year and all copper available is finding ready markets. Britain takes 80 per cent., Canada the rest.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Aluminium in the United States

Primary aluminium production in the United States in 1940 exceeded the peak reached in 1939 by 26 per cent., and consumption rose 35 per cent. above that in 1939, according to the United States Bureau of Mines. A total of 412,560,000 lb. of new aluminium, valued at 75,292,210 dollars, was produced in 1940, contrasted with 327,090,000 lb., valued at 64,600,000 dollars, in 1939. The apparent consumption of primary aluminium in 1940 totalled 454,034,409 lb., compared with 335,337,860 lb. in 1939. At the end of 1940 aluminium was being produced at a rate exceeding 500,000,000 lb. annually. In order to meet the requirements of the national defence programme, aluminium production will be further increased in 1941 and 1942 at the five reduction plants of the Aluminum Company of America, and at a new plant of the Reynolds Metals Company, at Lister, near Sheffield, Alabama. Output is expected to reach an annual rate exceeding 690,000,000 lb. by July, 1941, and 825,000,000 lb. by July, 1942, according to a report published by the Advisory Commission to the Council of National Defence. Of the 412,560,000 lb. of primary aluminium produced by the Aluminum Company of America in 1940, the reduction plant at Alcoa, Tennessee, accounted for 40 per cent.; at Massena, New York, for 35 per cent.; at Badin, North Carolina, for 14 per cent.; at Niagara Falls, New York, for 9 per cent.; and at Vancouver, Washington, for 2 per cent. The new plant at Vancouver, Washington, which commenced operations September 23rd, 1940, has contracted for a total of 162,500 kW of Bonneville power, and plans to produce aluminium at an annual rate of 150,000,000 lb. by the summer of 1941. Ingot production facilities also are being expanded substantially at Alcoa, Tennessee, and at the other reduction plants of the company. Long before the end of 1942 the Aluminum Company of America expects to be producing metal at a rate exceeding 700,000,000 lb. annually. In addition, the Reynolds Metal Company plans the production of primary metal at the yearly rate of 60,000,000 lb. in 1941, and to further increase this output in 1942. The tremendous demand for aluminium in 1940 is attributed chiefly to the high rate of activity in national defence industries.

The aeroplane is made chiefly of aluminium, and in 1940 this industry greatly increased its consumption and placed orders for much larger quantities of metal for 1941 and 1942. In addition to the building of a huge air armada, industry used the light but strong metal for many other uses in 1940. Contrary to the trend for many other materials greatly in demand for the rearmament programme, the price of aluminium declined 3 cents during 1940—from 20 cents per lb. at the beginning of the year to 17 cents before the close of the year. The Aluminum Company of America announced that these price reductions were in accordance with the company's policy of passing along to the public the benefits of research and economies of operations. The company also stated that when the emergency was past, there would be more aluminium at a lower price than was ever available before, and it was predicted that there would be more ways in which aluminium could serve industry and the nation. The imports of aluminium ingot, alloy, scrap, plates, &c., into the United States increased from 28,672,867 lb., valued at 3,385,113 dollars, in 1939, to 36,167,625 lb., valued at 4,737,228 dollars, in 1940—a 26 per cent. advance in quantity. Exports of domestic crude and semi-crude aluminium in 1940 were exceeded only by the record shipments in 1939. Exports totalled 55,682,201 lb., valued at 17,919,032 dollars, compared with 74,169,742 lb., valued at 20,871,551 dollars in 1939—a decrease of 25 per cent. Imports were chiefly from Canada (30,498,360 lb.) and France (5,011,958 lb.), and exports were chiefly to the United Kingdom (21,889,613 lb.), France 11,409,072 lb.), China (4,406,400 lb.).

The Pig Iron Market

All the pig iron plant is operating at close upon capacity and with production at this high level consumers are obtaining their requirements. Where the output of the particular description of pig iron is insufficient to meet the user's demands, imported iron is distributed. Whilst in most districts the pig iron industry has concentrated upon the manufacture of basic iron for the steel works, a fair tonnage of foundry iron is being produced in the Midlands and Scotland. The demand for foundry qualities is chiefly from engineers and others working upon armaments, and their requirements are chiefly for hematite and low phosphoric iron. Consumers who habitually take high phosphoric iron have little difficulty in satisfying their requirements from home producers, who are reported to have accumulated a certain amount for stock. The light castings industry, which is the largest user of this kind of iron, is still operating at below capacity, since there is, of course, little call now for private building purposes, and only a comparatively small proportion of the output has been absorbed into the war effort. Large tonnages of basic pig iron are being produced, and the supply of this description seems to be assured for a long time to come. Hematite is in active request by a large number of users, principally engaged upon essential work, and the whole of the home production plus imported iron is being distributed. The Control insists upon the greatest economy in the use of hematite, and many consumers have to use refined iron in their mixtures, in order to lessen the demand for the former description. It is understood, however, that the position will improve later on, and that fresh imports have been arranged which should materially ease the situation

The Midlands and South Wales

There is little change in the steel position in the Midlands. Although there has been a slight relaxation of pressure in some departments, notably in the demand for joists and structural material, large tonnages, judged by normal trading conditions, continue to pass into consumption. The call for the lighter sections has not declined, and large quantities are being absorbed. With such huge outputs the structural engineers are able to obtain all the material they need on fairly early delivery terms. The plate position differs since, while it is claimed that in some directions the situation is easier and users are able to obtain the plates they want, in general the works are flurried with orders and are only able to offer extended delivery. The sheet mills continue to operate at capacity, and consumers are exerting pressure to obtain supplies of black and galvanised sheets. The demand also seems to be spread over all gauges. Most of the mills have enough work in hand to keep them employed for some months, and are reluctant to accept fresh orders, although in cases of a variety of work they have to fall in with the instructions of the Control. Bars, both large and small sizes, are in active demand, since firms engaged upon armament work are particularly heavy users. The increasing demand for special steels has also been a feature of the position, and considerable quantities are passing to the munition and armament makers, the aircraft manufacturers, and similar industries. The re-rolling industry in the Midlands is working to capacity, and production is on a high scale, as there is now no lack of semis. In fact, most of the works have accumulated some stocks for an emergency. Large tonnages of small bars are being turned out, as well as good quantities of the lighter structural material and strip. The iron and steel trades in South Wales are all fully employed, chiefly upon work of national importance. The demand from the shipyards for steel has increased lately, and is absorbing good quantities of heavy finished steel. There is a strong demand for billets and sheet and tin-plate bars, but the recent restriction on supplies to the tin-plate makers is strictly enforced. The active demand for sheets is also reflected in the busy conditions ruling at the South Wales works. Most of this material, however, is required for Government purposes, and there is little left to satisfy the ordinary commercial demand.

Copper and Tin

Whilst the copper situation in this country is comfortable and the industries engaged upon war work are receiving full supplies, the announcement that a large-scale scheme of industrial mobilisation will shortly be put into operation has aroused some speculation as to whether some strain may be thrown upon the supply position owing to larger quantities of copper being required. It is possible, however, that the production of finished copper materials is nearly at its peak in Great Britain, since all the finishing plants have been fully employed since the beginning of the war. There is little doubt, however, that if increased quantities are required they will be forthcoming, and there is also the possibility that further imports of semi-finished copper from the United States may be required. In America the position is not regarded as tight, although the whole of the domestic production is being absorbed. The American rearmament programme is taking up big tonnages, and last week its was stated that the Metals Reserve Company would allocate supplies of copper from Government stocks in March. Licences in the United States appear to be available for the shipment of copper to Great Britain and Empire countries, but apparently there is not much surplus for export to other countries. The exports of copper from the United States in January totalled 13,639 tons. Japan received the largest quantity of 9006 tons, Great Britain coming next with 1239 tons, and China third with 1130 tons. . . . The London tin market has continued firm partly on account of further buying by United States consumers. Apparently the tension in the Far East, although it has become less threatening, is still worrying American users, who are taking steps to maintain their stocks. British export licences are still only sparingly granted. A meeting of the International Tin Committee is to be held during March, and it is expected that the discussions will centre around the renewal or otherwise of the Restriction Scheme. On the other hand, it is thought unlikely that this rather thorny question will be finally settled at one meeting.

Lead and Spelter

There has been no important change in the British lead position, and not only are the war industries getting all the metal they need, but firms manufacturing for export and some engaged upon work coming within the non-essential category are able to obtain supplies. The future position of this metal does not give cause for any concern, since not only are there some stocks, but there is a considerable reserve of scrap metal which could be used if necessary. It is expected, however, that the consumption of lead in Great Britain is likely to rise with the speeding up of armament and munitions production. . . . Whilst the consumption of spelter in Great Britain continues at a high rate, the supplies reaching this country appear adequate to meet the demand, although there is less surplus metal available for non-essential work than is the case in some other non-ferrous metals. In the United States the tightness referred to in recent weeks is still noticeable, and it is practically impossible to obtain export licences, although it is understood that some countries, including Japan, would be glad to purchase good quantities. Last week it was reported that the United States authorities had asked their spelter producers not to sell their products on the New York commodity market, and it is now stated that all dealings in zinc on that market have ceased. The American spelter statistics for 1940, which have just been published, show that the production in the United States during last year totalled 643,386 short tons, and the consumption 696,497 tons. The stocks on January 1st amounted to only 12,884 tons, compared with 65,995 tons on January 1st, 1940. As the consumption in the United States in recent months is calculated at 60,000 tons per month this is less than one month's supply.

Notes and Memoranda

Rail and Road

A LOOP FOR SWITZERLAND.—An early start is to be made in the construction of a goods loop line from Geneva Cornavin Station to La Praille Port. The work involves the construction of one tunnel under the city and two bridges across the Rhone and Arve rivers.

ROAD VEHICLE REPAIR.—The Ministers of Transport and Supply have set up a committee to advise them on the supply of motor vehicle spares and accessories and the provision of maintenance and repair facilities for civilian road transport. Mr. W. E. Rootes, President of the Society of Motor Manufacturers and Traders, is the chairman.

PULLMAN CARS REQUISITIONED.—The railways serving Washington, D.C., did their part in alleviating the temporary hotel shortage due to the inauguration of President Roosevelt for a third term by parking some eighty-eight Pullman cars in the yards and using them as hotels. All lines serving the capital ran extra trains to take care of the large number of out-of-town visitors who came to witness the inauguration and the parade which followed.

LONDON'S TRAVEL INFORMATION BOOTHS.—That the recently opened information booths in London are appreciated by the travelling public is shown by the fact that during a recent week nearly 24,000 inquiries were received. During a recent period of four weeks the staffs of these booths have helped intending passengers to solve upwards of 90,000 transport problems. Busiest of all the booths is that in Trafalgar Square, where in one week inquiries numbered 2800—not far short of one every minute.

NEW LOCOMOTIVE.—The Baldwin Locomotive Works have delivered and the West Maryland Railway Company is now placing in service twelve 4–6–6–4 single-expansion high-capacity freight locomotives. The tractive force of these locomotives is 95,500 lb.; the driving wheels are 69in. in diameter; they have a combined heating surface of 5770 square feet, and carry a working pressure of 250 lb. per square inch. The four cylinders are 22in. diameter by 32in. stroke. The locomotives will operate between Hagerstown, Md., and Connellsville, Pa., over a line 171·4 miles long.

A NEW DEE BRIDGE AT ABERDEEN.—During a visit to Aberdeen on Monday, March 10th, by their Majesties the King and Queen, the Queen opened the new bridge across the River Dee at Aberdeen, which she named the King George VI Bridge. The new bridge will serve as a link on the main road from the city to the south, and supersedes the 400-year-old bridge. It consists of three elliptical arches, the outer span being 100ft. and the centre span 120ft., with two flood water arches under the south bridge road. It has a width of 75ft. and has two footways and two carriageways. The bridge is built in reinforced concrete, with a facing of granite, which adds an appropriate touch of local harmony. The cost of the bridge was £150,000. It was constructed to the designs and specification of the city engineer, Mr. T. F. Henderson, M. Inst. C.E., and Mr. F. C. Mears, of Edinburgh, the consulting architect. The contractor was Mr. W. J. Anderson.

Air and Water

LOSS OF TRAWLERS.—The Board of Admiralty regrets to announce that H.M. Trawlers "Remillo" and "Cobbers" have been sunk.

TO PROTECT A DAM.—In connection with the construction of a dam in the White River canyon, near Enumclaw, Wash., a large covering will be used to protect the dam's impervious core from rainfall and snow. This tent, heavily reinforced underneath by rope and cable and raised or lowered by great winches on the floor of the canyon, will be suspended over the centre of the dam site.

A TUNNEL RECORD.—A main drainage tunnel to be known as the Carlton has just been completed at the Cripple Creek Gold Mines, Colo., in the record time of 513 days for 5 miles. The tunnel, 10ft. by 11ft. in cross section, will drain the Ajax, Vindicator, Cresson, Portland, and American Eagle mines. It was started in August, 1939, and is a year ahead of expected progress though driven mostly through hard Pikes Peak granite.

AMERICAN TOLUOL PLANTS.—America's first petroleum-toluol plant started production in December ahead of schedule at the works of the Shell Oil Company, Houston, Texas. A second process, whereby toluol is to be produced by the pyrolysis or similar treatment of petroleum constituents, is under investigation. The Shell plant is privately owned, but the Humble Oil Company has been subsidised by the Army for the construction and operation of a plant at Baytown, Texas.

WATER POWER IN LATVIA.—A scheme, which has cost more than 2½ million pounds, is nearing completion at Kegums, Latvia, where a new water power plant built by Swedish firms has at present three turbine units with a capacity of about 75,000 H.P., while later a fourth set will be installed, making a total of 102,000 H.P. The work was begun at the end of 1936. In addition to the power station and the transmission lines, the Swedish contractors have built the dam structure, locks for the river traffic and a high road bridge of steel across the river.

A CANADIAN-AMERICAN SCHEME.—The St. Lawrence scheme, a waterway project which concerns both Canada and America, moves forward slowly towards agreement. Experts from Canada and the United States met in conference recently at Detroit to receive the report of the joint committee appointed to make an engineering study of the International Rapids section of the river. This covers a draft agreement, which will be submitted to both Governments. It embodies all the navigation and power aspects of the scheme, from Montreal to the head of the Great Lakes. President Roosevelt sent a message indicating his support of the attempt, which failed in 1934, to obtain the approval of Congress to the treaty with Canada for the completion of the project. Following the failure in 1934, the Canadian and United States Governments had reopened negotiations which, however, were again broken off in 1938, but were resumed towards the close of 1939.

CHARCOAL FOR GAS MASKS.—Contracts valued at approximately 10 million dollars, in connection with supplies of gas mask charcoal and other chemicals used in gas defensive appliances, have been placed by the Chemical Warfare Service of the United States Army. About half this total is to cover the cost of construction of certain plants which will be owned by the Government though built by the firms concerned.

RAINBOW BRIDGE.—Construction of the new Rainbow Bridge over the Niagara River between the United States and Canada at Niagara Falls, N.Y., is progressing on schedule. Pouring of concrete for the abutments was completed before Christmas, and preliminary work for the erection of the main steel arch has been started. The span is scheduled to be opened in September. This structure, costing approximately 3,760,000 dollars, will be the longest fixed-end arch bridge in the world, and is being erected to replace the old Falls View or "Honeymoon" span destroyed by ice in January, 1938. The structure is being constructed about 400ft. north or downstream of the site of the old span. The new crossing is 1450ft. long, including a 950ft. steel arch.

Miscellanea

SOUTH AFRICA FOR CORUNDUM.—As a result of the war the South African corundum industry has again come into its own. During the first nine months of last year the production of corundum rose by nearly 100 per cent., aggregating 3178 tons as compared with 1660 tons in 1939. South Africa holds the world's principal source of supply. The deposits from which the bulk of the production has been derived are located in the northern and north-eastern Transvaal over an area of more than 3000 square miles.

DALTON RELICS FOUND.—During one of the raids on Manchester a number of relics of Dalton, the eminent chemist, were buried in ruins. Now round about a dozen have been retrieved after an eight-day search in the burnt-out premises of the Society in George Street. They included several partly burnt pages of a manuscript book of Dalton's, containing notes in his handwriting on his atomic theory made long before he gave the theory to the world. Among the other objects were three small porcelain mugs used by Dalton in some of his experiments.

SHALE OIL IN QUEENSLAND.—Under an amendment to the Mining for Coal and Mineral Oil Acts of Queensland, Australia, the State will only demand in future a 2 per cent. royalty on oil extracted from coal or shale, and that royalty will not be charged for the first twelve months of commercial production. A 10 per cent. royalty is charged on face or flow oil—that is, oil obtained from a well by boring. The extraction of oil from coal or shale entails a distilling plant, and the amendment should give a reasonable chance of putting the extraction business on a commercial and economic basis.

ALLOYS TO CONTROL STEEL PRODUCTION.—"Grainal" is the name that has been adopted for a group of alloys designed to meet the close specification limits required by automotive, armament, machinery and other large industries. They are the product of the Vanadium Corp., of America, and it is claimed for them that an addition of a few pounds of these ingredients to ordinary carbon steels and low alloy steels results in hardness and other physical properties of more highly alloyed steels. Observation indicates that the manner of functioning is entirely different from alloying agents in conventional alloy steels.

HARDNESS TESTING OF PLATES.—The Detroit Testing Machine Company, of Detroit, Mich., has introduced a Brinell hardness tester for inspecting wide plates at any point without removal from the conveyor. The base embodies a work support rail, which runs between the conveyor rollers slightly below flush when idle. When a test is being made this rail is brought into contact with the bottom of the plate to take the load. In operation the plate passes over the rollers the desired distance and is held in that position by the work support rail. Tests can then be made at any point or points across the width.

SURVEYING QUEENSLAND.—Speaking in the Queensland Legislative Assembly at the end of last year, the Minister of Mines announced the winding up of the work of the Northern Australia Aerial, Geological, and Geophysical Survey. It had completed a great deal of field work, and had taken photographs over the Northern Territory, Cape York Peninsula, the Cloncurry district, the Palmerston field, the Hodgkinson field, and the Central district as far south as Blair Athol. The geologists had worked on these photographs, and mosaics had been prepared to show the topography of the country. Valuable information had been obtained, and it would serve as a ready means of telling prospectors where it was considered advisable to carry out prospecting operations and where not.

PUBLICITY LEAFLETS.—The Ministry of Labour and National Service has issued leaflets, entitled "Going Away on War Work" (P.L. 83) and "Engineering Training for Women" (P.L. 84). The first contains a special foreword by the Minister of Labour and National Service, and provides answers to some of the questions likely to be asked by people who are leaving their homes to take up war work in other areas. The second leaflet is devoted to women's training for wartime work in the engineering industry. In this leaflet women are told how to apply for training, what types of courses are available, and how long training takes. The leaflet also briefly describes what engineering work is like and deals with such questions as training allowances (including allowances for dependants) and training away from home. Copies of the leaflets may be obtained from any employment exchange or direct from the Ministry of Labour and National Service (Public Relations Branch), Montagu House, Whitehall, S.W.1.

REFINING NICKEL ORES.—An improved method of refining low-grade nickel ores has been developed by the managing director of the Japan Nickel Company. The ore used is a serpentine rock of wide occurrence in Japan, and which usually contains only 0·3 per cent. of nickel, 6·7 per cent. of magnesite and small quantities of chromium. Details of the treatment are scanty, but the final product may be a ferro-nickel containing 20 per cent. of nickel, which can be directly used in the manufacture of alloy steels. A plant for the operation of the process has been erected by the company at Kisekimachi, Gunma Prefecture. The company was the first to enter the Japanese nickel industry.

Personal and Business

MR. J. GORDON MILLER, of Hardypick, Ltd., Sheffield, has been elected a Vice-President of the Institution of Factory Managers.

MR. FRANK PARKINSON, chairman of Crompton Parkinson, Ltd., has been appointed Deputy Director-General of Contracts, Ministry of Supply.

MR. J. W. GRANT, Assistant Traffic Controller at Southampton Docks, has retired after forty-five years' service with the Southern Railway Company.

WE regret to note the death on March 6th of Mr. Frederick Pollard, chairman and managing director of Frederick Pollard and Co., Ltd., Leicester.

THE STAVELEY COAL AND IRON COMPANY, LTD., announces that MR. N. R. REES has been appointed foundries general manager in place of the late Mr. J. B. Allan.

MR. GILBERT S. SZLUMPER, Railway Control Officer in the Ministry of Transport, has been appointed by the Minister a member of the Railway Executive Committee.

MR. R. T. GARRETT, a director of Anderson, Green and Co., and a member of the Port of London Authority, has been elected Chairman of the National Joint Council of Port Labour Employers.

E. F. MACTAGGART and W. Edmund Evans, consulting chemical engineers, of 14, Old Queen Street, Westminster, London, S.W.1, inform us that they have recently acquired the cement and steel testing practice, carried on by the late Mr. E. W. Monkhouse.

MR. W. J. DAWSON, of Hadfields, Ltd., has been awarded the E. J. Fox Medal of the Institute of British Foundrymen in recognition of his work as Chairman of the Steel Castings Research Committee and other activities connected with the foundry industry.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Marine Engineers

To-day, March 14th.—Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Annual general meeting. 12 noon. Luncheon, 1 for 1.15 p.m.

Institution of Automobile Engineers

Saturday, March 15th.—LONDON GRADUATES: 12, Hobart Place, S.W.1. "The Cathode-ray Oscillograph Engine Indicator Unit in Theory and Practice," D. C. Neaves. 3 p.m.

Monday, March 17th.—SCOTTISH CENTRE: Inst. of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "Some Notes on an Extended Test of Creosote Mixture in C.I. Engines," W. Allen. 6.30 p.m.

Institution of Electrical Engineers

Saturday, March 15th.—N. MIDLAND STUDENTS: Hotel Metropole, King Street, Leeds. Programme of films. 2.30 p.m.

Institution of Engineers-in-Charge

Saturday, March 15th.—St. Bride Inst., Bride Lane, Fleet Street, E.C.4. "Fuel Saving Charts and their Economic Interpretation," W. Goldstern. 2 p.m.

Institution of Naval Architects

Wednesday, April 2nd.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. Annual general meeting. 12.30 p.m.

Junior Institution of Engineers

Saturday, March 22nd.—39, Victoria Street, Westminster, S.W.1. "The Chemist, the Chemical Engineer, and the Mechanical Engineer," P. A. Cartwright. 2 p.m.

Keighley Association of Engineers

To-day, March 14th.—Victoria Hotel, Keighley. "The Control of Machine Tools," H. C. Town. 7.30 p.m.

Saturday, March 22nd.—Victoria Hotel, Keighley. Annual dinner. 6.45 p.m.

Manchester Association of Engineers

Saturday, March 15th.—Midland Hotel, Manchester. Tea dance. 2.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, March 14th.—Mining Inst., Newcastle-upon-Tyne. "Some General Observations on Vibration," J. Calderwood. 6 p.m.

Royal Institution of Great Britain

Tuesday, March 25th.—21, Albemarle Street, London, W.1. "The Physical Condition of the Planets," Sir James Jeans. 2.30 p.m.

Royal Society of Arts

Wednesday, March 26th.—John Adam Street, Adelphi, W.C.2. "Discovery and Invention," Sir Richard Gregory. 1.45 p.m.

Sheffield Metallurgical Association

Saturday, March 15th.—198, West Street, Sheffield. "Modern Methods of Metallurgical Analysis," E. J. Vaughan. 3 p.m.